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PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

# MISSOURI HEADWATERS BASIN
# KELLEY RESERVOIR DAM
# BEAVERHEAD COUNTY, MONTANA
# MT-1563

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PREPARED FOR:

HONORABLE TED SCHWINDEN
GOVERNOR, STATE OF MONTANA

RATTLESNAKE RESERVOIR COMPANY
(OWNER/OPERATOR)

PREPARED BY:
HOSKINS-WESTERN-SONDEREGGER, INC.

APRIL, 1981

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TABLE OF CONTENTS


| Paragraph | | Page |
|---|---|---|
| | EXECUTIVE SUMMARY | i |
| | PERTINENT DATA | iii |
| | CHAPTER 1 - BACKGROUND | 1 |
| 1.1 | INTRODUCTION. . . . . | 1 |
| 1.1.1 | Authority and Scope. . . . . | 1 |
| 1.1.2 | Purpose. . . . . | 2 |
| 1.1.3 | Inspection . . . . . | 2 |
| 1.2 | DESCRIPTION OF PROJECT. . . . . | 3 |
| 1.2.1 | General. . . . . | 3 |
| 1.2.2 | Regional Geology . . . . . | 3 |
| 1.2.3 | Seismicity . . . . . | 4 |
| 1.2.4 | Site Geology . . . . . | 5 |
| 1.2.5 | Design and Construction History. . . . . | 5 |
| | CHAPTER 2 - INSPECTION AND RECORDS EVALUATION | |
| 2.1 | HYDRAULICS AND STRUCTURES . . . . . | 6 |
| 2.1.1 | Principal Spillway . . . . . | 6 |
| 2.1.2 | Emergency Spillway . . . . . | 6 |
| 2.1.3 | Outlet . . . . . | 7 |
| 2.1.4 | Freeboard. . . . . | 7 |
| 2.2 | HYDROLOGY, CLIMATOLOGY, AND PHYSIOGRAPHY . . . . . | 8 |
| 2.2.1 | Climatology and Physiography . . . . . | 8 |
| 2.2.2 | Reservoir Storage and Spillway Discharge . . . . . | 8 |
| 2.2.3 | Estimated Probable Maximum Flood . . . . . | 9 |
| 2.2.4 | Flood Routing. . . . . | 9 |
| 2.3 | GEOTECHNICAL EVALUATION . . . . . | 10 |
| 2.3.1 | Embankment . . . . . | 10 |
| 2.3.2 | Foundation Conditions, Seepage, and Drainage . . . . | 11 |
| 2.3.3 | Stability. . . . . | 11 |
| 2.4 | PROJECT OPERATION AND MAINTENANCE . . . . . | 12 |
| 2.4.1 | General. . . . . | 12 |
| 2.4.2 | Dam. . . . . | 12 |
| 2.4.3 | Reservoir. . . . . | 12 |
| 2.4.4 | Warning Plan . . . . . | 12 |

## CHAPTER 3 - FINDINGS AND RECOMMENDATIONS


| | | |
|---|---|---|
| 3.1 | FINDINGS. . . . . | 13 |
| 3.1.1 | Size, Hazard Classification, and Safety Evaluation . | 13 |
| 3.1.2 | Embankment Dam . . . . . | 13 |
| 3.1.3 | Principal Spillway . . . . . | 13 |
| 3.1.4 | Emergency Spillway . . . . . | 14 |
| 3.1.5 | Outlet Works . . . . . | 14 |
| 3.1.6 | Spillway and Reservoir Capacity. . . . . | 14 |
| 3.1.7 | Operation and Maintenance . . . . . | 14 |
| 3.2 | RECOMMENDATIONS . . . . . | 14 |
| | REFERENCES. . . . . | 16 |


## PHOTOS


| | | |
|---|---|---|
| 1 | Overview, Kelley Reservoir and Dam | 17 |
| 2 | Upstream Face from Left Abutment | 17 |
| 3 | Upstream Face from Right Abutment | 18 |
| 4 | Downstream Face from Right Abutment | 18 |
| 5 | Crest from Left Abutment | 19 |
| 6 | Downstream Face and Principal Spillway from Left Abutment | 19 |
| 7 | Left Side of Principal Spillway Crest | 20 |
| 8 | Left Side of Principal Spillway | 20 |
| 9 | Right Side of Principal Spillway | 21 |
| 10 | Downstream from Principal Spillway | 21 |
| 11 | Trash Rack and Inlet Structure for Conduit | 22 |
| 12 | Control Works at Top of Gate Well | 22 |
| 13 | Conduit Outlet | 23 |
| 14 | Conduit Outlet and Exit Channel | 23 |
| 15 | Downstream from Crest of Dam | 24 |
| 16 | Emergency Spillway Approach Channel, Looking Upstream | 24 |
| 17 | Emergency Spillway Control Section and Exit Channel | 25 |
| 18 | Emergency Spillway Exit Channel, Where It Returns to Creek | 25 |
| 19 | Watershed and Left Bank of Reservoir | 26 |

PLATES


1 Site Plan and Vicinity Map

2 Dam Cross Section at Outlet

3 Dam Center Line Profile

4 Principal Spillway Profile and Emergency Spillway Profile

5 Principal Spillway Cross Sections and Emergency Spillway Cross Section

6 Elevation Area and Storage Curves

7 Principal Spillway Rating Curve

8 Emergency Spillway Rating Curve

9 34" WSP Outlet Discharge Rating Curve

10 Kelley Irrigation Dam Reconstruction - Construction Details

11 Kelley Irrigation Dam Reconstruction - Construction Details

12 Kelley Irrigation Dam Reconstruction - Construction Details

# EXECUTIVE SUMMARY

Under contract with the Seattle District Corps of Engineers and with representation from the State of Montana Department of Natural Resources and Conservation, Kelley Reservoir Dam was inspected by Hoskins-Western-Sonderegger, Inc., on 19 September 1979, under the authority of Public Law 92-367. Kelley Reservoir Dam is located in Beaverhead County, Montana, approximately 17 miles northwest of Dillon.

This report was compiled from information obtained during an on-site inspection, a review of operation records, and analysis of hydrologic and hydraulic data. Findings were compared to engineering criteria currently accepted by most private and public agencies engaged in dam design, construction, and operation.

## PRINCIPAL FINDINGS AND EVALUATIONS

Kelley Reservoir is located in the Beaverhead National Forest and is operated under a Department of Interior easement. It is used for irrigation storage and for recreation. The project consists of a natural lake and an embankment to raise the lake elevation for irrigation storage. The reservoir has a drainage area of approximately 24.6 square miles (including that of Estler Lake located about 4 miles upstream), surface area of approximately 44 acres at the principal spillway crest, and storage at the minimum dam crest of approximately 850 acre-feet.

In accordance with the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1), the 26-foot-high Kelley Reservoir Dam (MT-1563) is classified as being of small size and as having a significant (Category II) downstream hazard potential, due to the presence of approximately 2 inhabitable structures below the dam.

Inspection criteria (Ref. 1) recommend that the Spillway Design Flood (SDF) for a small-sized project with a significant downstream hazard potential be in the range of the 100-year flood to one-half of the Probable Maximum Flood (PMF). Based upon the involved risk, we recommend that this project be capable of handling one-half of the PMF. The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonable possible in the region.

During the dam safety analysis, an estimated PMF, resulting from a 24-hour Probable Maximum Precipitation (PMP) storm was developed for the drainage basin. The resulting PMF has a volume of approximately 19,920 acre-feet, including inflow from a breach of Estler Lake Dam, located upstream on a tributary to Rattlesnake Creek. The reservoir level at the beginning of the 24-hour storm was assumed to be at the principal spillway crest elevation. Reservoir routings of the estimated 24-hour PMF indicate that the project will only handle approximately 1.5% of the PMF volume before overtopping, if the low-level outlet is fully closed, or 1.7% of the PMF volume before overtopping, if the low-level outlet is fully open. The dam is constructed of materials that will

probably erode and fail when overtopped by floodwaters. Such failure could endanger lives and cause considerable property damage. On the basis of the field inspection and the study of hydrologic and operational data, Kelley Reservoir Dam does not conform to the recommended guidelines with respect to discharge and/or storage capacity to safely handle the recommended SDF.

Vegetative evidence of possible foundation or embankment seepage was found all along the downstream toe of the embankment, in the abutment troughs, and on the right side of the concrete spillway chute; however, no seepage was observed. No piezometers are installed to measure water levels in the embankment or foundation, and there is no internal drainage system, other than the downstream filter or transition zone which could act as a drain depending on its composition. Based on conditions described in this report, it is our judgment that the dam may conform to the recommended guidelines (Ref. 1) with respect to slope stability; however, additional information is required to verify design assumptions and evaluate stability.

## PRINCIPAL RECOMMENDATIONS

Due to the availability of storage between the normal pool and the dam crest, the present project provides a small degree of flood protection to the downstream area. The intent of report recommendations is to maintain or improve project safety, if feasible, without decreasing this existing flood protection.

Develop and immediately place into operation a downstream warning plan, for use in the event of possible embankment failure. Establish and follow a formal maintenance plan.

Conduct more-detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity. Modify the project as studies indicate. Conduct embankment stability analyses and verify design assumptions with regard to embankment phreatic surface conditions and filter characteristics. Consider the effects of seismic loading. Modify the project as studies indicate.

Prior to performing engineering studies and remedial construction, coordinate all work with the U.S. Forest Service and the State of Montana Department of Natural Resources and Conservation to insure compliance with all pertinent laws and regulations.

Stephen H. Nickel
Professional Engineer

# PERTINENT DATA

## 1. GENERAL

| | |
|---|---|
| Federal Identification Number | MT-1563 |
| Owner/Operator | Rattlesnake Reservoir Company |
| Purpose | Irrigation |
| Location | Sec. 10, T6S, R11W<br>Beaverhead County, Montana |
| Watershed | Rattlesnake Creek |
| Downstream Hazard Potential | Significant (Category II) |
| Size Classification | Small |
| USGS Quadrangle | Ermont, Montana |

## 2. RESERVOIR

| | |
|---|---|
| Surface Area at Normal Pool (Spillway Crest) | 44 acres |
| Normal Storage (Principal Spillway Crest) | 614 acre-feet |
| Total Storage (Min. Dam Crest) | 850 acre-feet |
| Surcharge Storage | 236 acre-feet |
| Dead Storage | 90 acre-feet |
| Drainage Area | 24.6 square miles |
| Reservoir Water Surface Elevation (9/19/79) | 6997.0 feet (NGVD) |

## 3. PRINCIPAL SPILLWAY

| | |
|---|---|
| Type | Uncontrolled concrete chute |
| Crest Elevation | 7010.0 feet (NGVD) |
| Crest Width | 24 feet |
| Spillway Capacity (Min. Dam Crest) | 745 cfs |

## 4. EMERGENCY SPILLWAY

| | |
|---|---|
| Type | Uncontrolled earth channel |
| Crest Elevation | 7012.1 feet (NGVD) |
| Crest Width | 43 feet |
| Spillway Capacity (Min. Dam Crest) | 495 cfs |

## 5. OUTLET WORKS

| | |
|---|---|
| Type | Controlled, welded steel pipe with trash rack |
| Controls | Vertical slide gate with manual control from dam crest |
| Size | 34-inch-diameter welded steel conduit, encased in concrete |

5. OUTLET WORKS (Continued)

| | |
|---|---|
| Conduit Length | 103 feet |
| Inlet Invert | 6993.3 feet (NGVD) |
| Outlet Invert | 6989.0 feet (NGVD) |
| Normal Tailwater | Unknown |
| Discharge Capacity (Min. Dam Crest) | 135 cfs |

6. DAM

| | |
|---|---|
| Type | Zoned earth fill |
| Hydraulic Height | 26 feet |
| Crest Length | 230 feet |
| Minimum Crest Elevation | 7015.0 feet (NGVD) |
| Crest Width | 14 feet |
| Upstream Slope (As Built) | 1(V) on 2.7(H) |
| Downstream Slope (As Built) | 1(V) on 2.0(H) |

Note: All elevations referenced from the estimated principal spillway crest elevation of 7010.0 feet above the National Geodetic Vertical Datum (NGVD).

# CHAPTER 1

# BACKGROUND

## 1.1 INTRODUCTION

### 1.1.1 Authority and Scope

This report summarizes the Phase I inspection and evaluation of Kelley Reservoir Dam, owned and operated by the Rattlesnake Reservoir Company of Dillon, Montana.

The National Dam Inspection Act, Public Law 92-367 dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to conduct safety inspections of non-federal dams throughout the United States. Pursuant to that authority, the Office of the Chief of Engineers issued "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1) in May 1975.

The recommended guidelines were prepared with the help of engineers and scientists, highly experienced in dam safety, from many federal and state agencies, professional engineering organizations and private engineering consulting firms. Consequently, the evaluation criteria presented in the guidelines represent the comprehensive consensus of the engineering community.

Where necessary, the guidelines outline a two-phased study procedure for investigating and evaluating existing dam conditions so deficiencies and hazardous conditions can be readily identified and corrected. The Phase I study is:

(1) a limited investigation to assess the general safety condition of the dam;
(2) based upon an evaluation of the available data and a visual inspection;
(3) performed to determine if any emergency measures and/or additional studies, investigations and analyses are necessary or warranted; and
(4) not intended to include extensive explorations or analyses or to provide detailed alternative correction recommendations.

The Phase II investigation includes all additional studies necessary to evaluate the safety of the dam. Included in Phase II, as required, should be additional visual inspections, measurements, foundation exploration and testing, materials testing, hydraulic and hydrologic analyses, and structural stability analyses.

The authority for the Corps of Engineers to participate in the inspection of non-federally owned dams is limited to Phase I investigations with the exception of situations of extreme emergency. In these cases the Corps may proceed with Phase II studies but only to the extent

needed to answer serious questions relating to dam safety that cannot be answered otherwise. The two phases of investigations outlined above are intended only to evaluate project safety and do not encompass in scope the engineering required to perform design or corrective modification work. Recommendations contained in this report may be for either Phase II safety analyses or detailed design study for corrective work.

The responsibility for implementation of these Phase I recommendations rests with the dam owner and the State of Montana. It should be noted that nothing contained in the National Dam Inspection Act, and neither any action nor failure to act under this Act shall be construed (1) to create liability in the United States or its officers or employees for the recovery of damage caused by such action or failure to act or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam.

### 1.1.2 Purpose

The purpose of the inspection and evaluation is to identify conditions that threaten public safety, so that they may be corrected in a timely manner by non-federal interests.

### 1.1.3 Inspection

The findings and recommendations in this report were based upon visual inspection of the project, as well as interviews with owners and/or knowledgeable residents. Records of recent inspections and the SCS construction drawings of the last major dam reconstruction (December 1965) were provided for reference. Inspection procedures and criteria were those established by the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1).

Personnel present during the inspection included:

Louis Boitano, Civil Engineer, Seattle District Corps of Engineers; and
Art Taylor, Civil Engineer, State of Montana, Department of Natural Resources and Conservation.

Hoskins-Western-Sonderegger, Inc., personnel who participated in the field inspection and contributed to this report are:

Stephen Nickel, Geotechnical Engineer, Team Leader;
Michael McMeekin, Hydrologist/Hydraulics Engineer; and
Gene Holtorf, Hydrologist/Hydraulics Engineer.

This report has been reviewed by representatives of the Rattlesnake Reservoir Company, the Montana Department of Natural Resources and Conservation, the Soil Conservation Service (SCS), and the U.S. Forest Service. Their written comments have been included in the Appendix of this report.

## 1.2 DESCRIPTION OF PROJECT

### 1.2.1 General

Kelley Reservoir Dam (MT-1563), owned and operated by the Rattlesnake Reservoir Company under a Department of Interior easement, forms what is primarily an irrigation impoundment and recreational area. The reservoir is located on Rattlesnake Creek in portions of Sections 3, 9, and 10, T6S, R11W, Beaverhead County, Montana, approximately 17 miles northwest of Dillon (see Plate 1). The dam on Rattlesnake Creek was first constructed in the early 1900's. The original dam was completely removed and replaced by a new structure, designed by the SCS, which was completed in 1965. Kelley Reservoir has a drainage area of approximately 24.6 square miles (3.5 square miles of which is the drainage area and surface area of Estler Lake), a reservoir surface area of approximately 44 acres and storage of approximately 614 acre-feet at the principal spillway crest elevation of 7010.0 feet, and a maximum storage of approximately 850 acre-feet at the minimum dam crest elevation of 7015.0 feet. The reservoir also has approximately 90 acre-feet of dead storage. The principal spillway, located approximately 50 feet south of the left (north) abutment, is an uncontrolled, 24-foot-wide, concrete chute discharging to Rattlesnake Creek. The emergency spillway, located approximately 85 feet south of the right abutment of the dam, is an uncontrolled, 43-foot-wide, earth channel discharging to Rattlesnake Creek. A 34-inch-diameter, welded steel pipe with a wet well and manually controlled slide gate at the mid-point of the pipe make up the irrigation outlet works for the dam. The outlet works are located in the embankment approximately 135 feet south of the left dam abutment. (See Plate 11).

Based upon visual reconnaissance and engineering judgment, approximately 2 inhabitable structures could be affected by a sudden breach of Kelley Dam. The dam is approximately 26 feet high and impounds approximately 850 acre-feet of water at the minimum dam crest elevation. Kelley Reservoir Dam, therefore, is classified as being small in size and has a significant (Category II) downstream hazard potential classification (Ref. 1).

### 1.2.2 Regional Geology

Kelley Reservoir Dam is in the Pioneer Mountains. The Pioneer Mountains lie in the southwest corner of Montana. They are bounded by the Anaconda Range to the north, the Beaverhead Mountains in the Bitterroot Range to the west across the Big Hole valley, and the Ruby and Tobacco Root Ranges to the east across the Beaverhead Valley.

The Pioneer Mountains are essentially composed of a complex suite of igneous rocks, the Boulder Batholith, which has intruded into the much older sedimentary and metamorphic rocks of the area. The intrusion of the Boulder Batholith, along with intensive block and thrust faulting, has been the major factor in the geologic structure of the Pioneer Mountains. Present topography is the result of Pleistocene glaciation and valleyfill in the lower intermountain areas.

The northern Rocky Mountain region, prior to Late Cretaceous time, was essentially a flat plain partially flooded by shallow seas. At the end of the Mesozoic Era, of which the Cretaceous is the last geologic epoch, this entire area became geologically active. Three things exemplify this activity: (1) Cretaceous uplift; (2) Late Cretaceous thrust faulting; and (3) Late Cretaceous-Tertiary intrusive activity, i.e., the Boulder Batholith. The regional uplifting of the continental crust brought the earth up in several north-south trending blocks. The west sides of the faulted blocks, or mountains, are higher in elevation and have characteristically abrupt scarps, while the east sides of the blocks have long, gentle slopes.

The uplifted land became subjected to erosion. As the sediments were transported downslope, they filled the intermountain valleys with debris ranging from muds and sands to gravels and cobbles. These valley-fill sediments attain a depth of several thousand feet in the axis of the mountain valleys.

Pleistocene alpine glaciation of Wisconsin Age (12,000 years before present) sculptured typical alpine glacial features including cirques, headwalls, and troughs in the upper elevations of the Pioneer Mountains. In lower elevations, glacial deposits of terrace gravel, stream bed alluvium, landslide rubble, and glacial drift occur.

### 1.2.3. Seismicity

Kelley Reservoir Dam lies in Seismic Zone 3, as indicated by the Seismic Zone Map (Ref. 1). The seismic probability of this regional setting is one of potential for major damage and is based on the known distribution of damaging earthquakes in the region.

The "Preliminary Map of Young Faults in the United States", by the U.S. Geological Survey (Ref. 2), indicates suspected activity along the northern expanse of the Pioneer Mountains and Holecene activity directly east, along the northwestern side of the Tobacco Root Range. The Geologic Map of Montana shows extensive faulting prior to the Cenozoic Era in the immediate vicinity of Kelley Reservoir. The Humbolt Anticline, in the southeast section of the Pioneer Mountains, has produced several lateral faults. The valley of Rattlesnake Creek is the result of one of these faults.

Local earthquakes significant enough to be reported in References 3 and 4 occur in 2 epicentral areas. One of these is to the northeast along a line from 20 miles northwest of Helena to 25 miles north of Bozeman, while the other is to the southeast in northeast Idaho, northwest Wyoming, and the adjoining areas of Montana. Of these two epicentral areas, the one is 75 to 100 miles northeast and the other is 50 to 150 miles southeast of the project site. Two earthquakes of significant intensity that occurred in the tri-state region southeast of the project site were the Hebgen Lake, Montana, earthquake (8 August 1959), that had an intensity of X (Modified Mercalli), and another southeast of

Dillon, Montana, and southeast of the project area (23 November 1947), that had an intensity of VIII. The three largest reported earthquakes northeast of the Pioneer Mountains have had intensities of VIII. One of these earthquakes had its epicenter at a point 25 miles north of Bozeman (27 June 1925), while the other two occurred at Helena (18 October and 31 October 1935).

In the vicinity of the project there have been numerous other earthquakes in this century (Ref. 3 and 4). In an area bounded by the 44th and the 46th parallels and by the 110th and the 112th meridians (including the tri-state region), there have been more than 50 earthquakes with intensities of V and more than 10 with an intensity of VI. The closest reported earthquakes to the project site have occurred approximately 50 miles east near Ennis and Virginia City, Montana. The largest of these had an intensity of VI and occurred near Ennis (10 March 1977). The exact distance from the epicenter of this earthquake to the project site is not known.

The Pioneer Mountains are in a seismically active area with the potential for a damaging earthquake. This warrants that special attention be given to the dams in the area that have been constructed without consideration of the effects of earthquakes.

### 1.2.4 Site Geology

Kelley Reservoir lies in the western limb of the Humbolt Anticline. Quaternary soils, talus, alluvium, and moraine cover Belt Series bedrocks, including the Mission Canyon limestone, the Jefferson dolomite, and the Wolsey shale. The Belt strata are exposed and surrounded by Paleozoic and Mesozoic formations. Small stock-like bodies of quartz monzonite occur locally.

Faulting is obscured near the dam by Quaternary sediments but is strongly evident in the valley above and below the structure. Numerous subsidiary faults occur at 45° to 90° from the primary north-south trending fault, along which the valley of Rattlesnake Creek has formed.

The dam is constructed on a terminal moraine which had been incised by natural stream flow. The thickness of the morainal material varies from perhaps 20 feet at the abutments to less than 5 feet at the conduit location.

### 1.2.5 Design and Construction History

The original Kelley Reservoir Dam was constructed under a U.S. Department of Interior easement, probably in the early 1900's. There are no plans existing for the original construction, which was completely removed and replaced by a new structure, designed by the Soil Conservation Service and completed in December 1965. The new structure is still administered under the original U.S. Department of Interior easement. Inspection reports made since the new construction was completed indicate no major maintenance problems with the reservoir and dam facilities.

# CHAPTER 2

# INSPECTION AND RECORDS EVALUATION

## 2.1 HYDRAULICS AND STRUCTURES

### 2.1.1 Principal Spillway

The principal spillway is located in the embankment, approximately 50 feet south of the left dam abutment. The spillway is an uncontrolled, concrete chute, 24 feet wide and approximately 4.5 feet deep at the crest. The concrete chute has a 16-foot-long, flat crest. Upstream of the crest, a 10-foot-long approach channel extends to the upstream face of the dam. Downstream of the crest the chute drops off at a uniform slope of 50%. At the end of the chute is a flip bucket energy dissipator. An irregular, earth and rock exit channel carries spillway discharges to Rattlesnake Creek. A log boom, located approximately 30 feet upstream of the crest, appears to be in good condition and is functional in keeping debris out of the spillway. The principal spillway can be seen in Photos 5 through 10, and the profile and typical cross sections can be seen on Plates 4 and 5.

The principal spillway structure appears to be in good condition, with no serious structural damage. The concrete is in serviceable condition with some surface erosion, two main cracks on the floor of the flat crest section, and some minor cracking in the walls. The asphaltic joint filler is missing from the concrete joint between the crest and the chute. No significant spalling of the concrete surfaces has taken place. The left wall of the chute is deflected inward approximately 1 to 2 inches at the downstream end of the crest section.

The discharge rating for the principal spillway was computed by assuming critical depth at the downstream end of the flat concrete crest and computing water surface profiles upstream into the reservoir using a Manning's "n" value of 0.012. The capacity of the spillway varies from 0 cubic feet per second (cfs) at the spillway crest elevation of 7010.0 feet to 745 cfs at the minimum dam crest elevation of 7015.0 feet. A complete discharge rating curve for the principal spillway is shown on Plate 7.

### 2.1.2 Emergency Spillway

The emergency spillway is located approximately 85 feet south of the right abutment of the dam and also discharges into Rattlesnake Creek. The spillway is an uncontrolled, earth channel, approximately 43 feet wide, with a minimum depth of approximately 3 feet. The channel surface is fairly flat and regular and is covered with a mixture of silt, sand, and gravel. The flat crest section is approximately 75 feet long. Upstream from the crest the channel slopes at approximately 4% to the reservoir. The channel downstream from the crest has an average slope of approximately 3% to its confluence with Rattlesnake Creek. The emergency spillway channel can be seen in Photos 16 and 18, and the profile and typical cross sections can be seen on Plates 4 and 5.

The emergency spillway appears to be in reasonably good condition with no significant erosion damage. The channel has no serious irregularities or debris obstructions. Vegetative cover on the spillway bottom and sides slopes is very sparse. Erosion of the emergency spillway channel could occur during high flows; however, this erosion should not pose any threat to the dam.

The discharge rating curve for the emergency spillway was computed by assuming critical depth at the downstream end of the flat crest and computing water surface profiles upstream into the reservoir using a Manning's "n" value of 0.040. The capacity of the spillway varies from 0 cubic feet per second (cfs) at the minimum spillway crest elevation of 7012.1 feet to 495 cfs at the minimum dam crest elevation of 7015.0 feet. A complete discharge rating curve for the spillway is shown on Plate 8.

### 2.1.3 Outlet

A low-level irrigation outlet is located through the base of the embankment, approximately 135 feet south of the left dam abutment. The outlet consists of 103 feet of 34-inch-diameter welded steel pipe, encased in concrete. The outlet is controlled by a vertical slide gate, which is located in a wet well approximately at the mid-point of the pipe and which is operated manually from the dam crest. The invert of the upstream end of the pipe has an elevation of 6993.3 feet, which is 21.7 feet below the minimum dam crest elevation. The invert of the downstream end of the pipe has an elevation of 6989.0 feet, which is 26.0 feet below the minimum dam crest elevation. A trash rack is located at the upstream end of the pipe. The irrigation outlet works can be seen in Photos 11 through 15.

The low-level irrigation outlet appears to be in very good condition. The trash rack appears to have some rust on it, although paint still shows. The concrete is in good condition showing only some surface erosion. The hand-crank operating control for the slide gate is in very good condition, as is its concrete base. The exposed portions of the 34-inch-diameter welded steel pipe have very little rust and appear to be in very good condition; however, the portion of the conduit within the embankment could not be inspected. The capacity of the irrigation outlet, assuming the water level to be at the minimum dam crest elevation, was computed to be 135 cfs. This capacity was based upon full pipe flow and assuming the control gate to be in the fully-opened position. The complete outlet discharge rating curve can be seen on Plate 9.

### 2.1.4 Freeboard

The normal pool elevation of Kelley Reservoir is assumed to be the crest elevation of the principal spillway, 7010.0 feet; thus, the vertical distance between the normal pool and the minimum dam crest is 5.0 feet. The effective fetch for wind-generated waves is approxmately

0.22 miles. The total wave run-up and wind set-up is approximately 2.0 feet (Ref. 5). Thus, the vertical distance between the minimum dam crest elevation and the wave height elevation above normal pool is 3.0 feet. With the surface of the water at the crest of the spillway, 3.0 feet of freeboard above the wave height would probably be adequate protection against wave overtopping in accordance with criteria in Reference 6.

Routings indicate that the dam will be overtopped during the recommended Spillway Design Flood (SDF). No freeboard exists, therefore, for that event (see Section 3.1.1).

## 2.2 HYDROLOGY, CLIMATOLOGY, AND PHYSIOGRAPHY

### 2.2.1 Climatology and Physiography

The climate of the area around Kelley Reservoir is continental and characterized by a large diurnal and seasonal temperature range. Extreme variability of wintertime temperatures results from the frequent occurrence of chinook winds which follow a Pacific maritime air mass invasion. The summers are characterized by warm days with low humidity and cool nights. Winters are cold and highly variable in severity from year to year and within a given year.

Dillon, located in Beaverhead County at an elevation of 5218 feet, is the climatological station nearest the damsite. Precipitation and climatological data from this station are not applicable to the damsite because of the 1790-foot elevation difference between Kelley Reservoir and the weather station. The average annual precipitation at Kelley Reservoir is approximately 30 inches (Ref. 7). The average expected date of the first freeze is August 23rd, and the average expected date of the last freeze is July 9th (Ref. 8).

The drainage basin above and including Kelley Reservoir has an area of approximately 24.6 square miles. Included in the drainage basin is that of Estler Lake Dam, which has an area of approximately of 3.5 square miles. Other than the main stream (Rattlesnake Creek) upon which Kelley Reservoir is built, there are no other developed perennial tributaries draining into the reservoir. Basin elevations range from the principal spillway crest elevation of 7010.0 feet to approximately 10,300 feet at the drainage divide. Basin vegetation consists of moderately thick pine, with some barren areas, and sparse grasses on rocky soils in the lower basin area. In the higher areas of the basin, all vegetation is sparse due to the extremely rocky surfaces.

### 2.2.2 Reservoir Storage and Spillway Discharge

Kelley Reservoir has a surface area of approximately 44 acres and a storage volume of approximately 614 acre-feet at the principal spillway crest elevation of 7010.0 feet. Approximately 100 acre-feet of storage is available between the principal spillway crest and the minimum emergency spillway crest elevation of 7012.1 feet. Approximately 240 acre-feet of storage is available between the principal spillway crest and the minimum dam crest elevation of 7015.0 feet. Discharges through the principal and emergency spillways, with the water surface at the

the minimum dam crest, are 745 cfs and 495 cfs, respectively, for a total of 1240 cfs. Discharge through the irrigation outlet under these conditions would result in an additional 135 cfs with the control gate in the fully-opened position. Complete discharge rating curves for both spillways and the irrigation outlet are shown on Plates 7, 8 and 9.

### 2.2.3 Estimated Probable Maximum Flood

The Probable Maximum Flood (PMF) is the flood expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. A storm, the intensity of which approached Probable Maximum Precipitation (PMP) intensity did occur in parts of Montana in June 1964.

Inspection criteria (Ref. 1) recommend that a small-sized project with a significant downstream hazard potential be capable of handling a Spillway Design Flood (SDF) in the range of the 100-year flood to one-half of the PMF. Because of the involved risk for this project, we recommend that the SDF be one-half of the PMF.

A PMP storm of 24-hour duration was applied to the Kelley Reservoir drainage basin. The 24-hour, 12-hour, 6-hour, and 1-hour PMP depths were estimated from National Weather Service Technical Paper 38(Ref. 9) to be 14.9 inches, 12.4 inches, 10.1 inches, and 5.8 inches, respectively. All 6-hour increments from 0 to 24 hours and the hourly increments of the maximum 6-hour increment were arranged in accordance with criteria in Weather Bureau Hydrometeorological Report No. 43 (Ref. 10).

The PMF was assumed to result from a PMP storm in the late spring over frozen ground. Thus, a constant soil loss rate of zero was applied throughout the 24-hour PMP storm, in accordance with Corps of Engineers recommendations. The resulting overall configuration of the 24-hour storm is not affected by losses in the soil,and, therefore, basin runoff is equal to basin rainfall for all storm increments. Direct precipitation onto the surface of the lake was also added in with no losses.

In evaluating the PMF for Kelley Reservoir, inflow from the Estler Lake drainage basin was also considered. Estler Lake Dam was assumed to breach at the time the dam was overtopped. All spillway discharges and all breach discharges were routed through the drainage basin to Kelley Reservoir and combined with inflows from the remainder of the Kelley Reservoir basin.

### 2.2.4 Flood Routing

The level of Kelley Reservoir at the beginning of the 24-hour PMP storm was assumed to be at the principal spillway crest elevation of 7010.0 feet, corresponding to assumed normal pool conditions. The total volume of the 24-hour PMF for Kelley Reservoir is approximately 19,920 acre-feet. Included in this volume is approximately 3,220 acre-feet from the Estler Lake basin, which would reach Kelley Reservoir through a

breach of Estler Lake Dam. Reservoir routings indicate that, with the control gate of the irrigation outlet closed, the reservoir will handle, through storage and spillway discharge, approximately 1.5% of the PMF volume before overtopping. With the control gate of the irrigation outlet fully open, the reservoir will handle approximately 1.7% of the PMF volume before overtopping. During the estimated PMF, overtopping of Kelley Reservoir Dam would occur prior to overtopping of Estler Lake Dam. Inflows from the Estler Lake basin would not, therefore, contribute to overtopping of Kelley Reservoir Dam; however, they are included in the total PMF volume.

PMF hydrographs were developed using the SCS dimensionless unit hydrograph. Reservoir routings of the inflow hydrographs were made using the Modified Puls method. The HEC-1 (Dam Safety Version) computer program (Ref. 11) was used for the hydrograph computations and reservoir routings.

## 2.3 GEOTECHNICAL EVALUATION

### 2.3.1 Embankment

The 26-foot high earth and rockfill dam is 230 feet long and has a crest width of 14 feet (see Plate 11). The upstream slope is generally 1(V) on 2.7(H) and the downstream slope is generally 1(V) on 2.0(H), according to field measurements. These slopes are flatter than those shown on the plans. According to the plans, borrow for the embankment was obtained off-site, except for what was obtained from the emergency spillway excavation. Sand and silt are exposed on the crest, while the upstream and downstream slopes are covered with rock. The plans (see Plate 11) show a zoned embankment, with an "impervious" core containing a partial concrete core wall,"filter" or transition zones on both sides of the core, and outer rock shells. Design documents indicate that the core (Zone 1) material is a clayey sand with gravel and that the transition or filter (Zone 2) material is a poorly graded sand with silt. Permeability of the core zone was estimated by us to be about .05 feet per day, whereas the Zone 2 permeability was estimated to be about 100 to 1000 times greater. The core and transition materials are moderately to highly erodible. The outer shells appear to be composed of sound rock of igneous and metamorphic origin, generally ranging in size from 3 inches to 12 inches in diameter, with some larger pieces.

Vegetation primarily occurs on the crest, which has about 50% coverage, mostly of sagebrush (see Photo 5). There are bushes at the top of both the upstream and downstream faces. In addition, weeds, grass, and bushes are growing on the downstream face all along the right side of the spillway chute, at the base of the downstream slope, and in both abutment troughs (see Photos 3, 4, 5, 6, and 8).

The outer shells appear to be composed of sound rock of igneous and metamorphic origin. The granular Zone 2 material was visible near the crest, and our impression was that the material corresponded to the design documents. Also at the crest, where the rock shells are

thin, the tops of the shells appear to have sagged a few inches below the crest elevation, possibly due to erosion of the underlying transition material.

The drawings show that a partial concrete core wall is incorporated in the embankment, near the embankment center line, between original Stations 1+36 and 2+22 (Plates 10 and 11). The wall does not reach the crest of the dam.

### 2.3.2 Foundation Conditions, Seepage, and Drainage

The dam is founded on a varying thickness of morainal deposit which may be quite pervious. The core wall was incorporated to limit seepage, but the core wall extends to bedrock only in the vicinity of the conduit and does ot extend laterally to the dam abutments. For these reasons, some seepage is to be expected.

No seepage water was found on the downstream face, at the downstream toe, or in the abutment troughs. However, vegetative evidence of possible seepage, in the form of bushes and tall grass, was found all along the downstream toe and in the abutment troughs up to an elevation roughly 15 feet below the crest of the dam. In addition, similar bushes were growing along the right side of the spillway chute in a strip roughly 10 feet wide from the crest to the toe (see Photos 4, 5, 6, and 8).

There was nothing to indicate that the dam included any type of internal drain; however, the design of the dam as a zoned embankment provides for drainage in that the downstream Zone 2 material (see Plate 11) will intercept any water seeping through the core and carry it to the base of the embankment, where it can seep into the foundation or through the Zone 3 rock shell to the downstream toe of the dam. It is not known whether the gradation of the Zone 2 material will allow this or whether it meets filter design criteria. Improper gradation could lead to either a piping failure of the core or a loss of the filter material through the rock shells. There are no piezometers installed in the dam.

### 2.2.3 Stability

During design for the reconstruction in 1965, a stability analysis was performed. However, no borings were made, and no shear testing was performed. The stability analysis, as performed by the SCS, was based on data correlated from other sites in the region, where similar materials prevailed. Saturation was assumed for the upstream filter or transition zone and for the core. The downstream filter or transition zone was assumed to operate as a chimney drain which was moist but not saturated. The Swedish Circle method was used for the analyses. Safety factors meeting or exceeding guideline standards were obtained; however, no mention was made in the design report of analysis for seismic conditions, which may control for this dam. It is our judgment that the embankment may conform to the inspection guidelines (Ref. 1). However,

more information is needed on the filter characteristics of the Zone 2 material, on the actual phreatic surface corresponding to normal pool conditions, on the shear strength of embankment materials, and on the seismic effects on stability. The vegetative evidence of seepage in the lower part of the embankment and along the right side of the spillway chute suggests that actual conditions may differ from those assumed in the design analyses.

## 2.4 PROJECT OPERATION AND MAINTENANCE

### 2.4.1 General

Operation and maintenance of Kelley Reservoir and Dam is the responsibility of the Rattlesnake Reservoir Company with technical assistance provided by the U.S. Forest Service. The project is operated under a U.S. Department of Interior easement granted prior to the construction of the original dam in the early 1900's. Although a documented plan for operation and maintenance of the reservoir and dam is not available, past records and inspection reports indicate a history of adequate maintenance. Accessibility to the area is only fair, but the dam is visited for maintenance at least once per year.

### 2.4.2 Dam

Although there is no formal maintenance plan for Kelley Reservoir, Forest Service inspection reports and site evidence indicate a fairly high level of maintenance activity. Current maintenance needs consist of the removal of debris collected by the log boom and the painting of rusty steel on the trash rack and on the exposed portion of the conduit at its outlet.

### 2.4.3 Reservoir

As previously mentioned, there is no formal plan for operation and maintenance of Kelly Reservoir, other than the responsibilities inferred in the original easement. Generally, the reservoir is allowed to fill in the fall, winter, and part of the spring, and storage is discharged for irrigation purposes during the remainder of the year.

Despite the lack of a plan, attention to maintenance has been favorable, with the owners correcting deficiencies when brought to their attention. From periodic inspection reports, the accumulation of debris in the reservoir seems to be the most significant maintenance item.

### 2.4.4 Warning Plan

There is no formal warning plan of action to warn downstream inhabitants or interests in the event of impending dam failure.

# CHAPTER 3

# FINDINGS AND RECOMMENDATIONS

## 3.1 FINDINGS

Visual inspection of Kelley Reservoir and Dam, supplemented by analysis of the project in terms of the recommended guidelines' performance standards, resulted in the following findings.

### 3.1.1 Size, Hazard Classificiation, and Safety Evaluation

According to the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1), Kelley Reservoir Dam is classified as small in size and has a significant downstream hazard potential rating. The recommended Spillway Design Flood (SDF) for this project is one-half of the PMF. The project can control only about 1.5% of the 24-hour PMF. Because the project is incapable of controlling the recommended SDF without overtopping and causing the dam to fail, Kelley Reservoir Dam does not conform to inspection guidelines with respect to storage and/or spillway capacity.

### 3.1.2 Embankment Dam

As noted in Section 2.3, the embankment appears to be in good condition. Although there is some vegetative evidence of seepage, no free water was found. At the time of the inspection, the pool was 13 feet below the principal spillway. There is no internal drain in the embankment, but the downstream Zone 2 material may act as a drain. Vegatative covering is sparse, but erosion is not a problem. There are no piezometers installed in the embankment or the foundation; therefore, the location of the phreatic surface is unknown.

Based on the design stability analysis and experience with similar structures and materials, the dam may conform to stability criteria in the recommended guidelines. However, more information is needed on the filter characteristics of the Zone 2 materials, the location of the phreatic surface under normal pool conditions, the strength of the foundation and embankment soils, and the effects of earthquake loading in order to fully evaluate stability.

### 3.1.3 Principal Spillway

The principal spillway, an uncontrolled, concrete chute, was found to be in good structural condition. There is no serious cracking or spalling of the concrete structure, but some surface erosion and minor cracking is apparent. The asphaltic joint material is missing from the joint at the top of the chute, the lack of which could cause damage to the concrete during freeze-thaw cycles and permit water to enter the embankment during spillway flow. The left wall of the chute is deflected inward approximately 1 to 2 inches at the downstream end of the crest section, but presents no immediate danger.

### 3.1.4 Emergency Spillway

The emergency spillway, an uncontrolled, earth channel, was found to be in reasonably good condition. No significant erosion damage was noted, possibly due to the infrequency of operation of the spillway to date. The non-cohesive soils in the channel sides and bottom, covered only by sparse vegetation, could experience serious erosion damage during operating of the spillway. This damage would not endanger the dam embankment.

### 3.1.5 Outlet Works

The irrigation outlet works were found to be in good, operational condition. The trash rack is serviceable, with some rust showing through the paint on the bars and with some minor surface erosion of the concrete structure. The hand-crank operating control and concrete gate well are in very good condition. The welded steel pipe conduit is in good condition, where visible, showing slight rust but no serious surface damage. The portion of the conduit within the embankment was not inspected.

### 3.1.6 Spillway and Reservoir Capacity

The reservoir storage capacity and spillway discharge capacities are insufficient to prevent overtopping during the recommended SDF. This investigation has determined that during the 24-hour PMP storm, the dam can handle only about 1.5% of the PMF with the control gate closed and 1.7% with the control gate open.

### 3.1.7 Operation and Maintenance

Operation and maintenance are performed by the Rattlesnake Reservoir Company, with technical assistance provided by the Forest Service. There is no formal operation plan for the reservoir. Water from spring runoff is stored in the reservoir and is released from the outlet as needed for irrigation. Consequently, the lake level fluctuates seasonally.

There is no formal maintenance plan for the dam, but the facility has a history of timely maintenance. Current maintenance needs are debris removal and rust removal and painting of the steel bars of the trash rack and of the exposed portion of the welded steel conduit.

There is no formal warning plan of action to warn downstream inhabitants in the event of impending dam failure.

## 3.2 RECOMMENDATIONS

Due to the availability of storage between the normal pool elevation and the dam crest, the present project provides a small degree of flood protection to the downstream area. The intent of the recommendations in this report is to maintain or improve project safety, if feasible, without decreasing this existing flood protection.

1. Immediately develop, implement, and periodically test an emergency warning plan for use in the event of dam overtopping.

2. After removing all rust, use a proven rust-resistant paint system to paint all rusted metal on the trash rack and on the exposed portion of the welded steel conduit.

3. Remove debris from the embankment and the spillway.

4. Inspect the outlet conduit and repair as required.

5. Conduct more-detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity. Include the effects of the upstream Estler Lake Dam Project in the studies. Modify the project as studies indicate.

6. Re-evaluate embankment stability and verify design assumptions with regard to the position of the embankment phreatic surface and the filter characteristics of the Zone 2 materials. Include an evaluation of stability during a design earthquake. These stability analyses should be performed by a qualified geotechnical engineer. Modify the project as studies indicate.

7. Develop and implement a periodic maintenance plan for the dams and appurtenant structures.

8. Establish a program for periodic, comprehensive, safety inspections at no more than 5-year intervals. These inspections should be performed by engineers qualified in the design, construction, operation, and maintenance of earth dams.

Prior to performing engineering studies and remedial construction, coordinate all work with the U.S. Forest Service and the State of Montana Department of Natural Resources and Conservation to insure compliance with all pertinent laws and regulations.

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2. Howard, K. A., et al, "Preliminary Map of Young Faults in the United States as a Guide to Possible Fault Activity," U. S. Geological Survey, Reston, Virginia, 1978.

3. U. S. Geological Survey, "Earthquake Information Bulletin," Washington D. C., 1973-1978.

4. U. S. Department of Commerce, Earthquake History of the United States, Publication 41-1, Washington D. C.

5. U. S. Army Corps of Engineers, Office of the Chief of Engineers, "Wave Run-up and Wind Set-up on Reservoir Embankments," Engineer Technical Letter No. 1110-2-221.

6. U. S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, Water Resources Technical Publication, U. S. Government Printing Office, Washington D. C., 1974.

7. U. S. Department of Agriculture, Soil Conservation Service, "Average Annual Precipitation in Montana," Portland, OR, 1977.

8. Caprio, J. M., "Montana: Average Dates of Freeze," Folders No. 81, 82, and 83, Montana Agricultural Experiment Station, Montana State College, Bozeman, Montana, March 1965.

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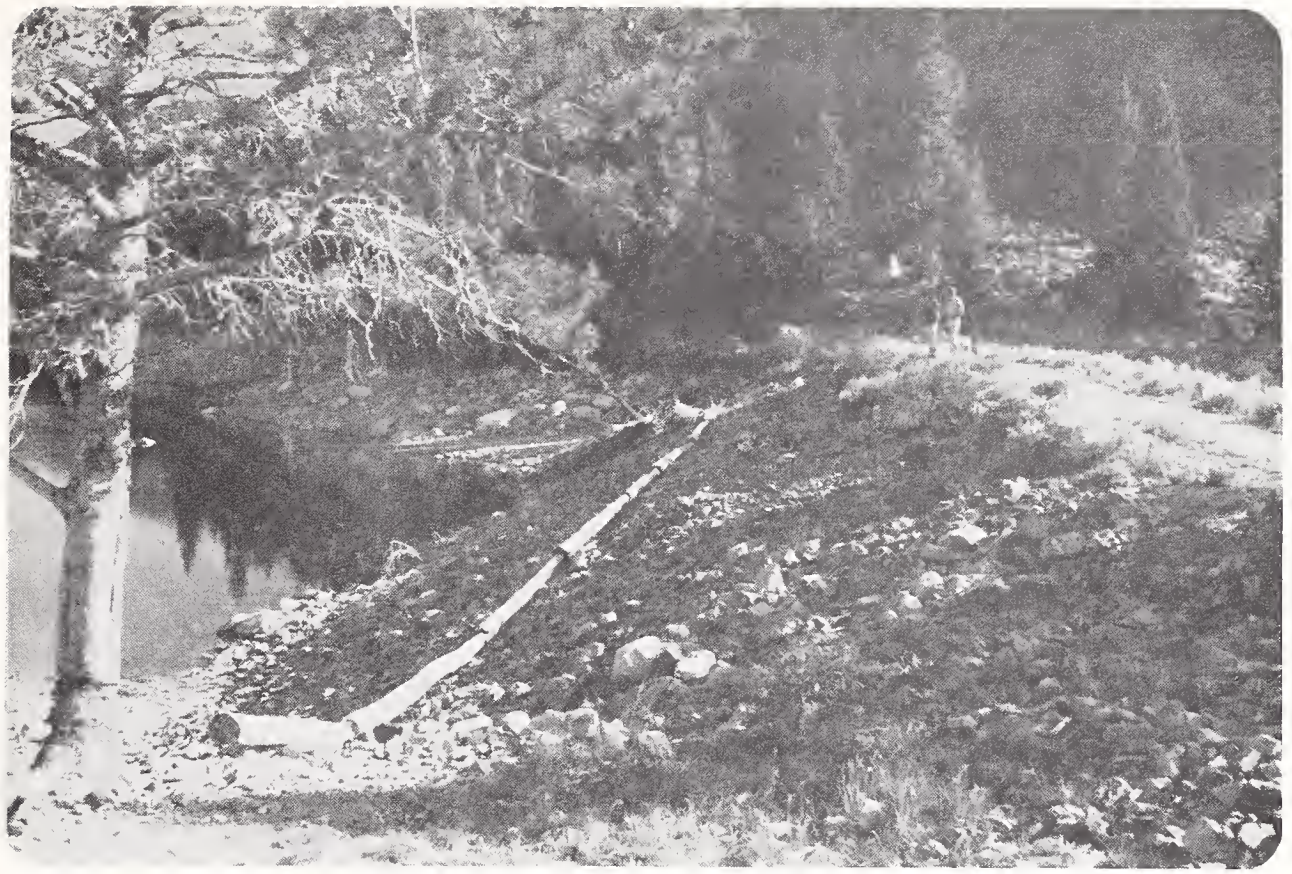
10. U. S. Department of Commerce, Environmental Science Services Administration, Weather Bureau, Probable Maximum Precipitation, Northwest States, Hydrometeorological Report No. 43, Washington, D. C., November 1966.

11. U. S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Users' Manual for Dam Safety Investigations, Davis, California, September 1978.

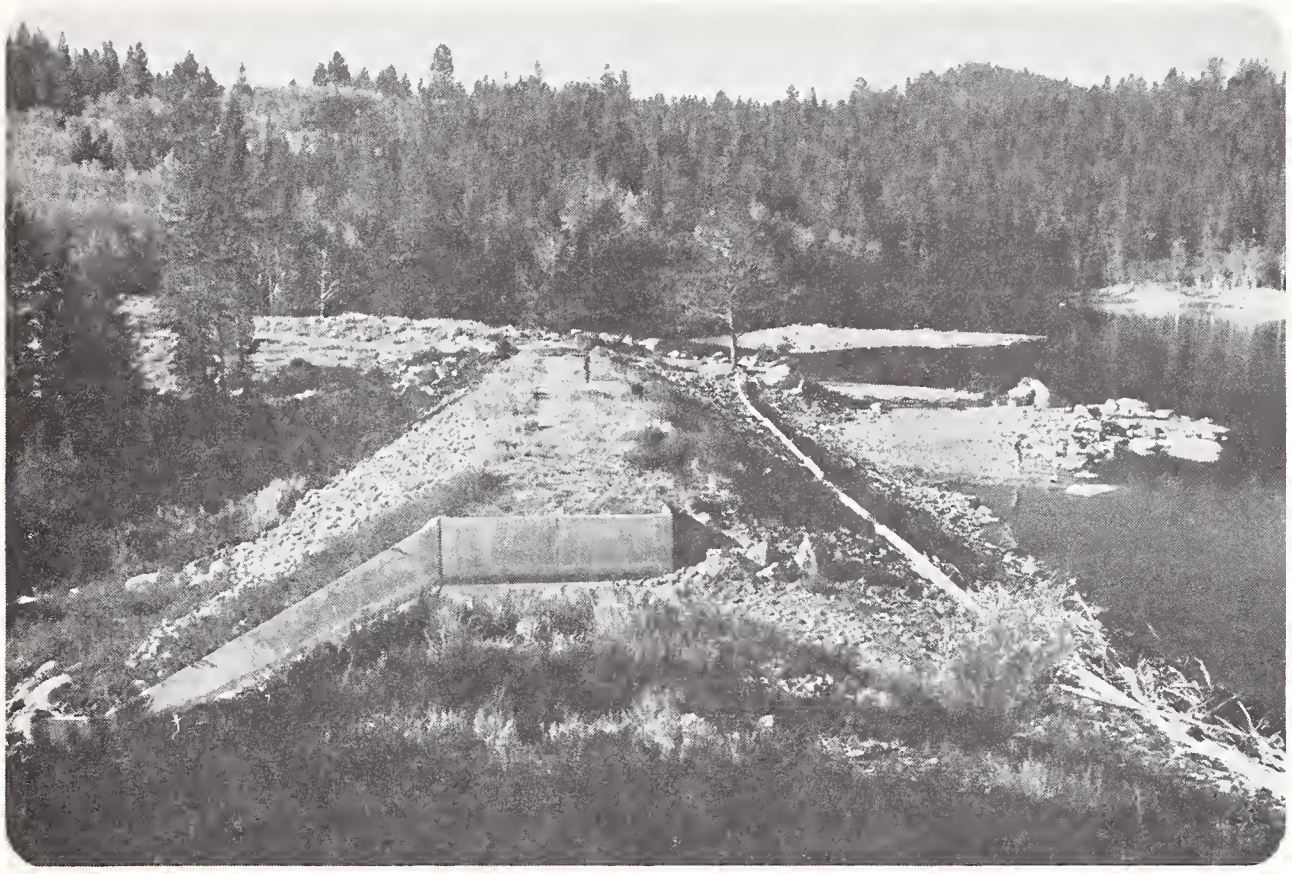
(PHOTO 1) Overview, Kelley Reservoir and Dam

(PHOTO 2) Upstream Face from Left Abutment

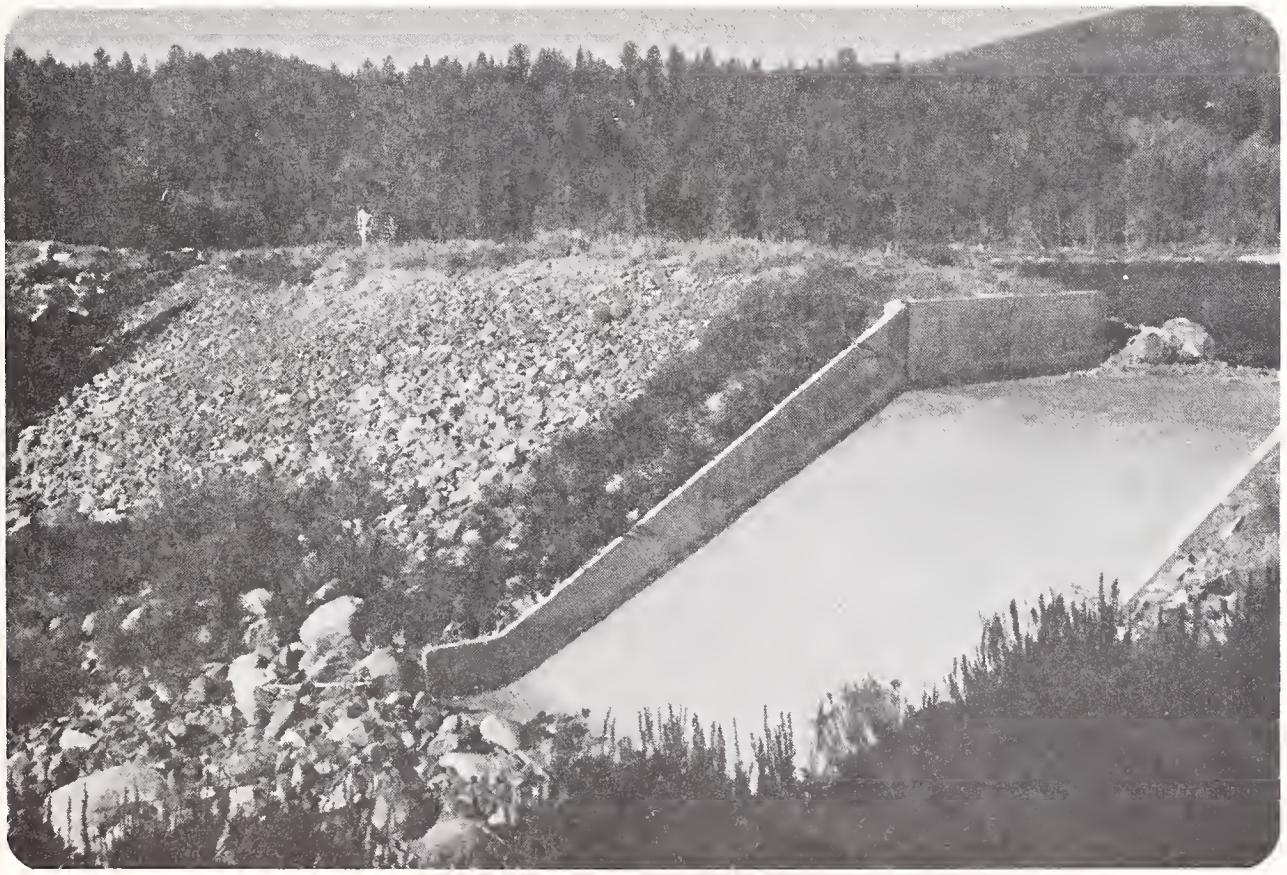


(PHOTO 3) Upstream Face from Right Abutment

(PHOTO 4) Downstream Face from Right Abutment

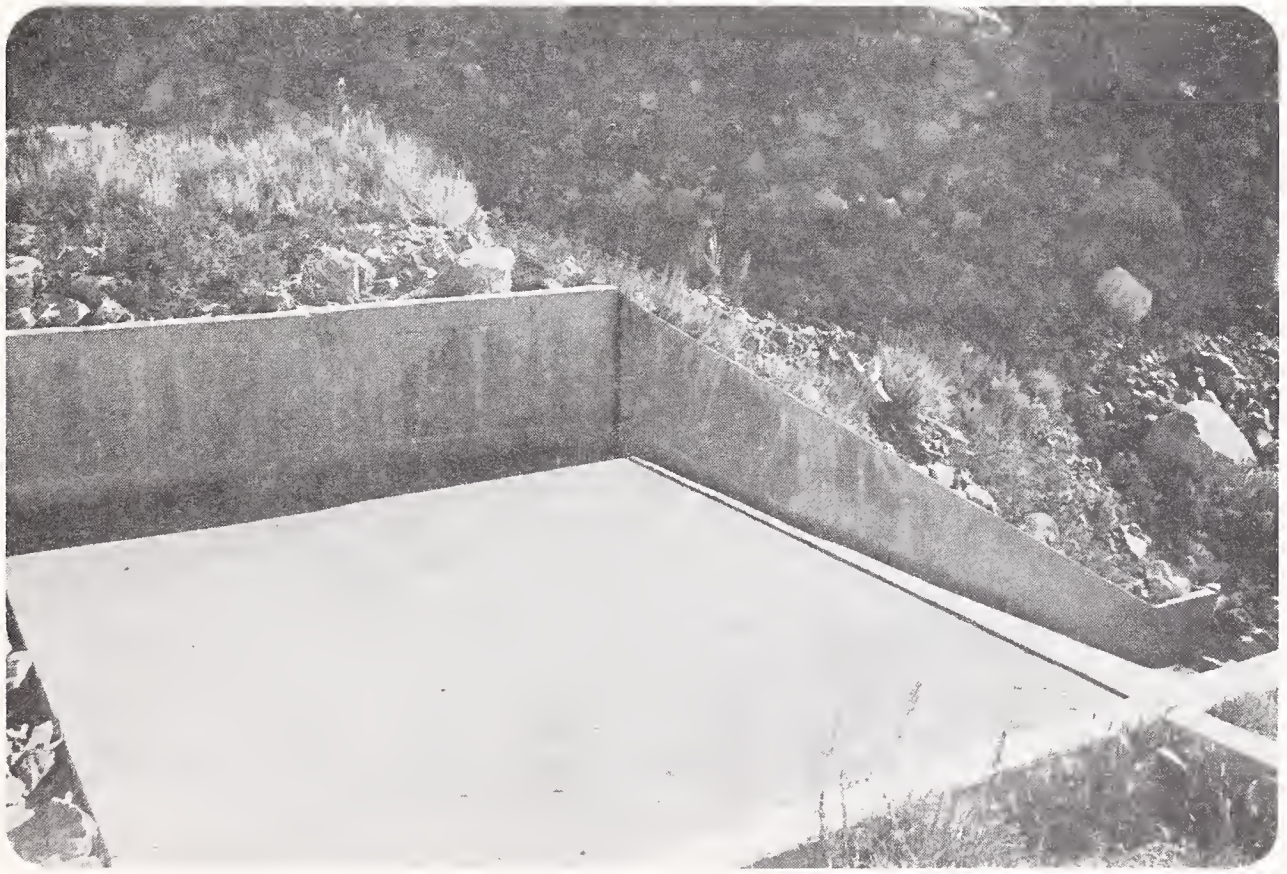


(PHOTO 5) Crest from Left Abutment

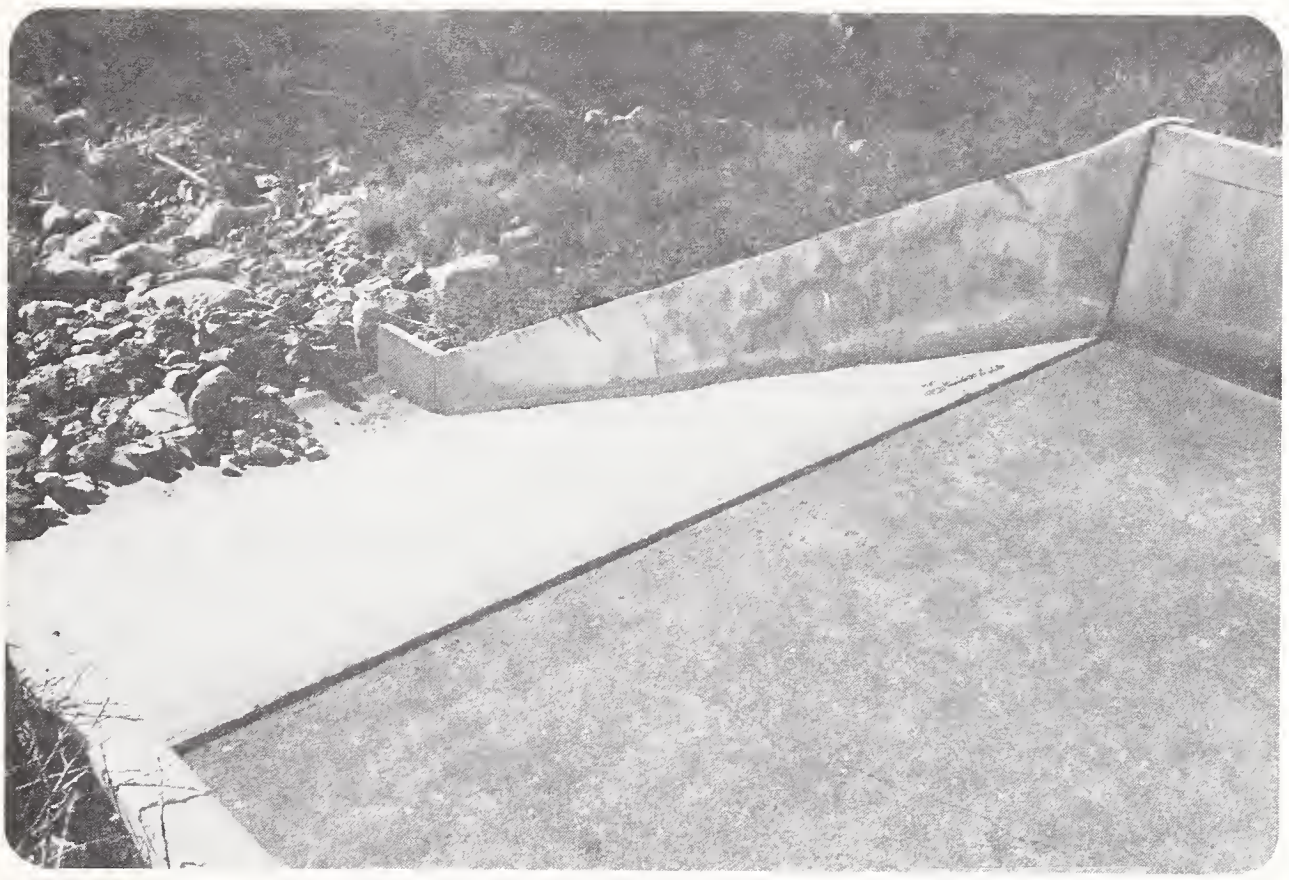


(PHOTO 6) Downstream Face and Principal Spillway from Left Abutment

(PHOTO 7) Left Side of Principal Spillway



(PHOTO 8) Left Side of Principal Spillway



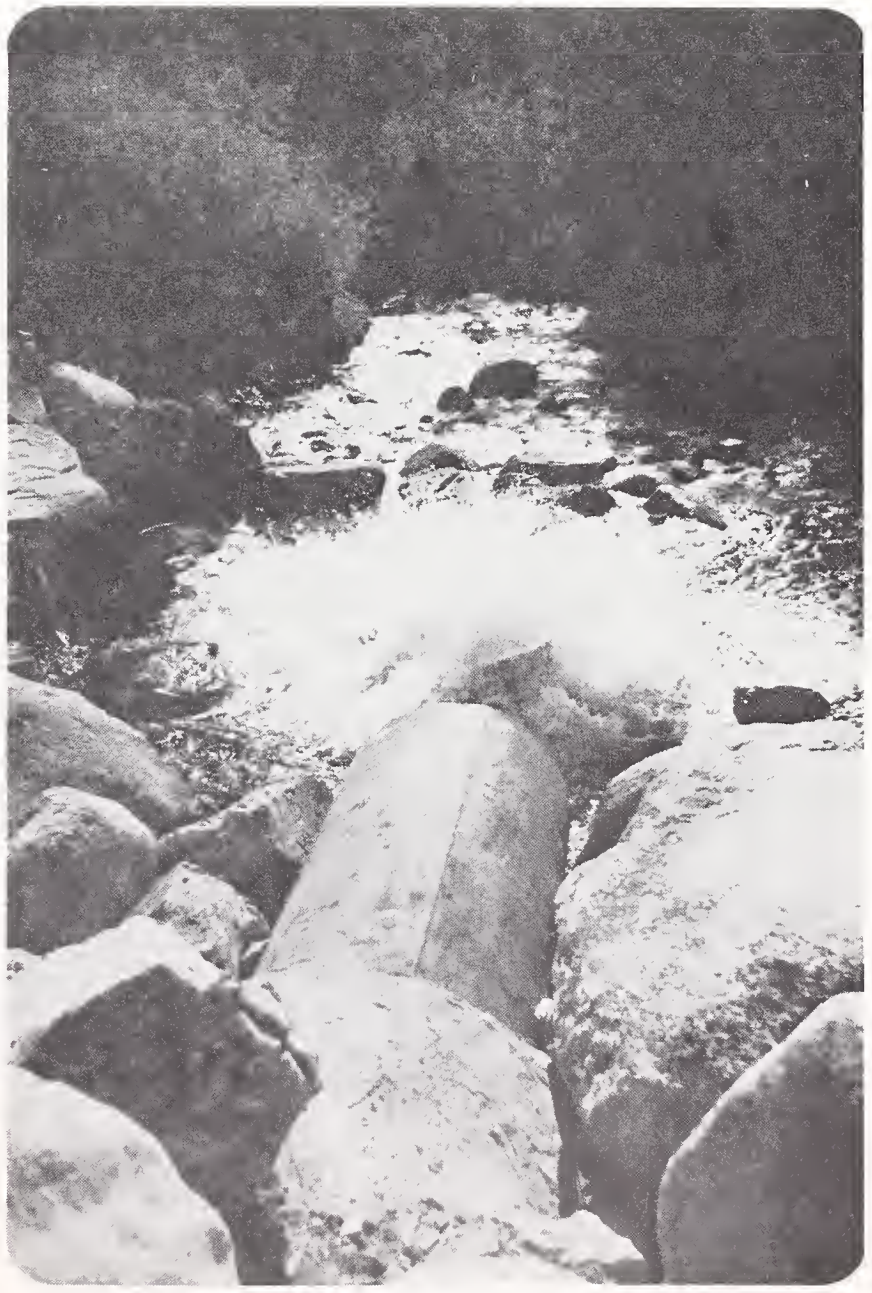
(PHOTO 9) Right Side of Principal Spillway

(PHOTO 10) Downstream from Principal Spillway

(PHOTO 11) Trash Rack and Inlet Structure for Conduit

(PHOTO 12) Control Works at Top of Gate Well

(PHOTO 13) Conduit Outlet



(PHOTO 14) Conduit Outlet and
Exit Channel

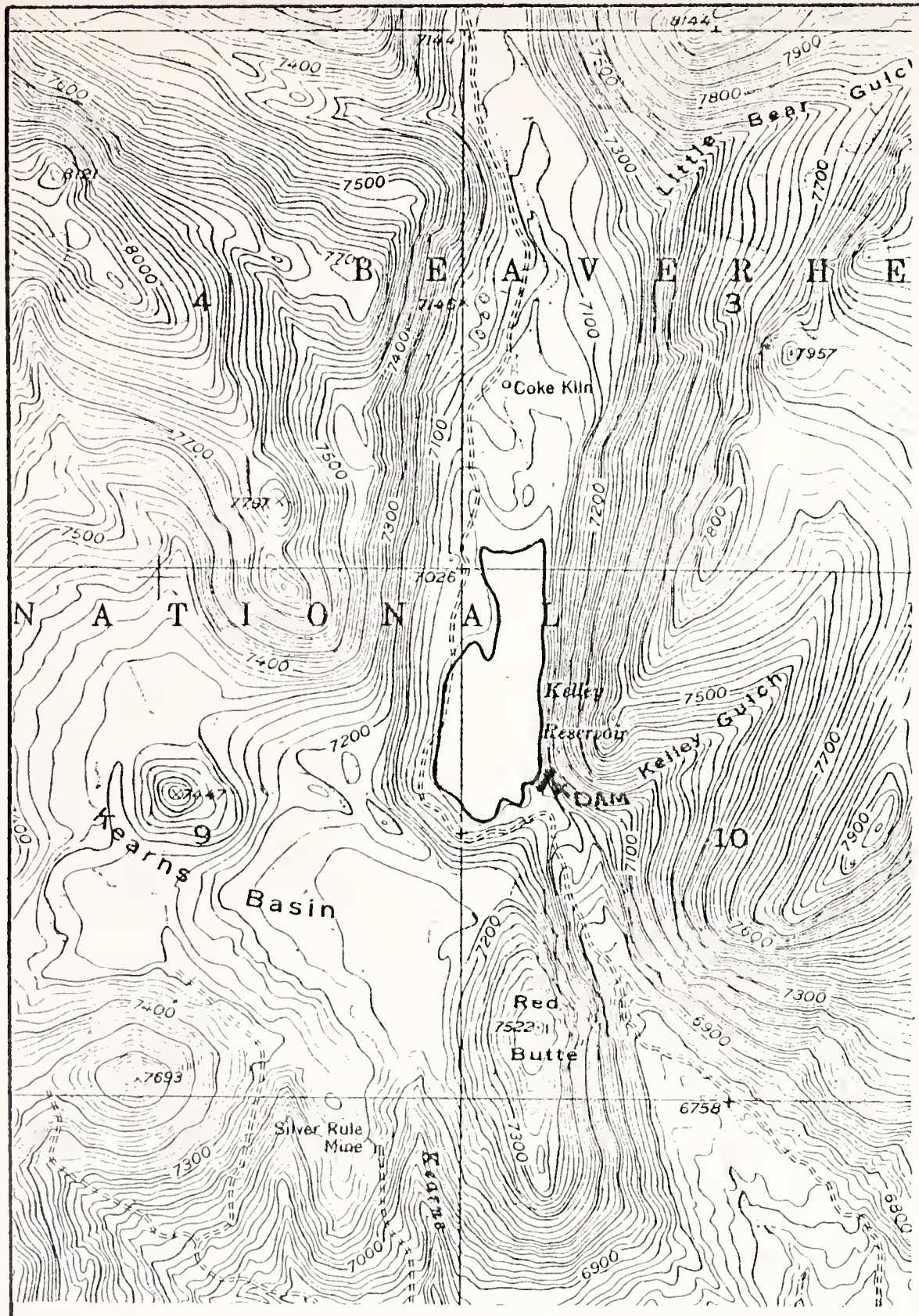
(PHOTO 15) Downstream from Crest of Dam

(PHOTO 16) Emergency Spillway Approach Channel, Looking Upstream

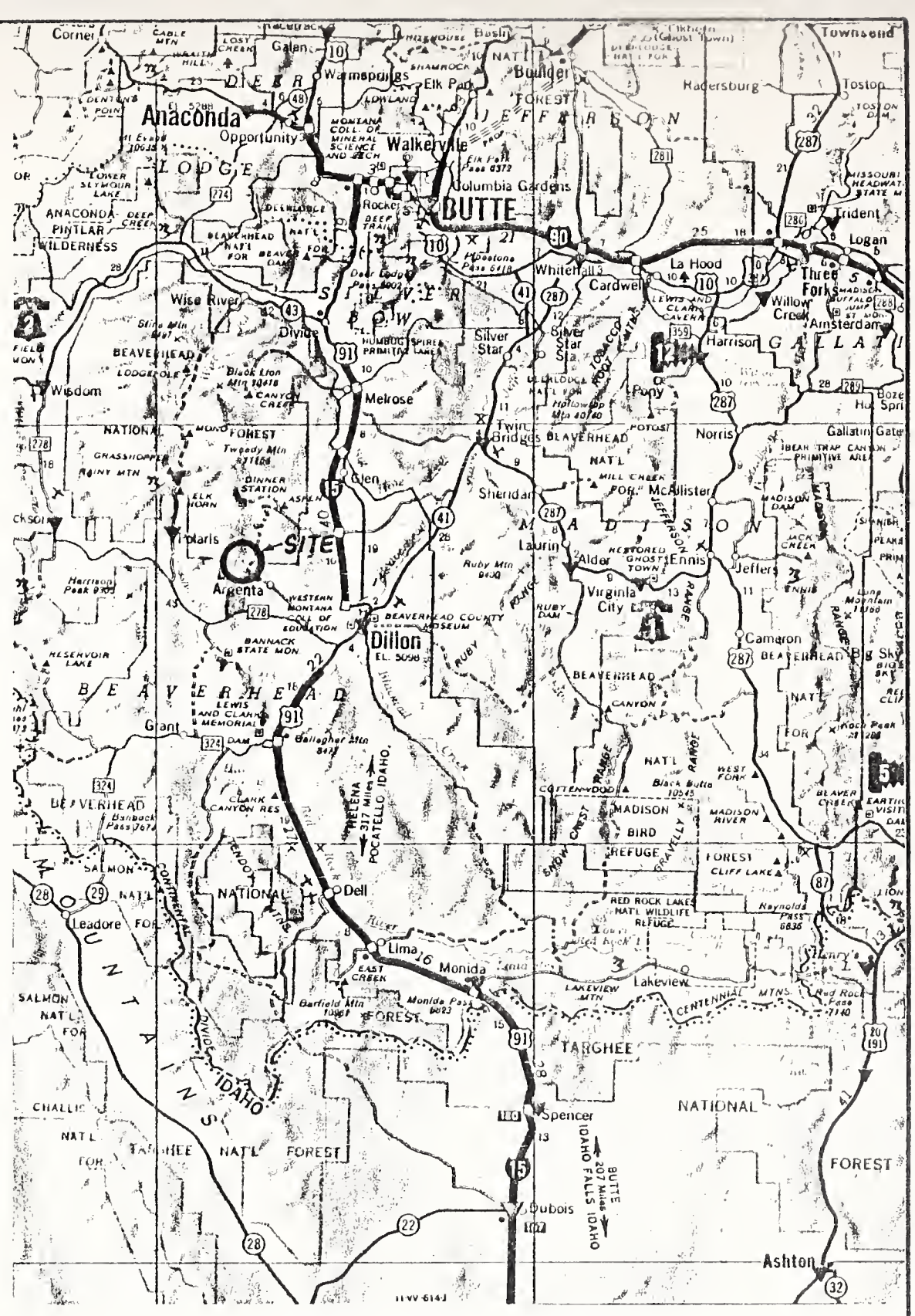
(PHOTO 17) Emergency Spillway Control Section and Exit Channel

(PHOTO 18) Emergency Spillway Exit Channel Where It Returns to Creek

(PHOTO 19) Watershed and Left Bank of Reservoir




SITE PLAN



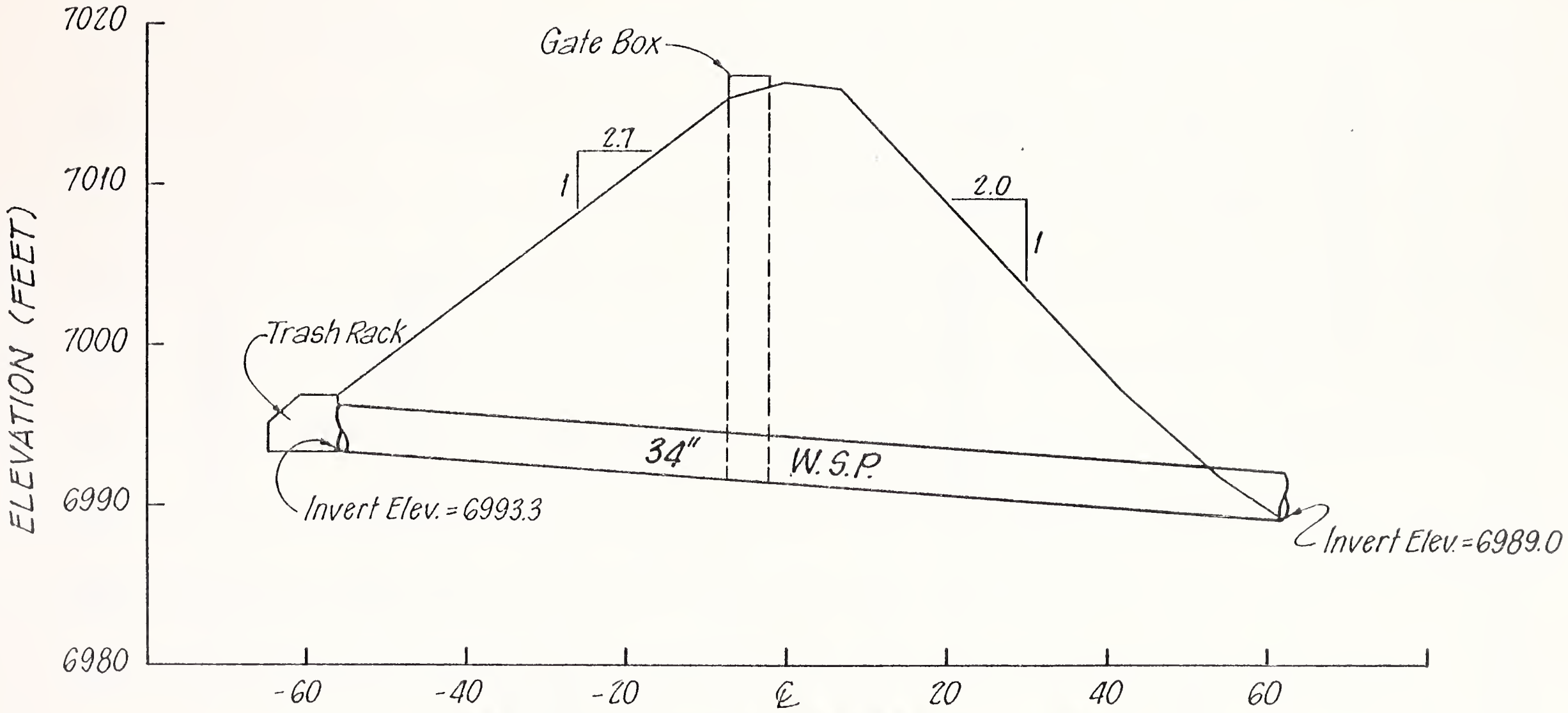

VICINITY MAP

N

# KELLEY RESERVOIR DAM

PLATE 1

# KELLEY RESERVOIR DAM
## Montana

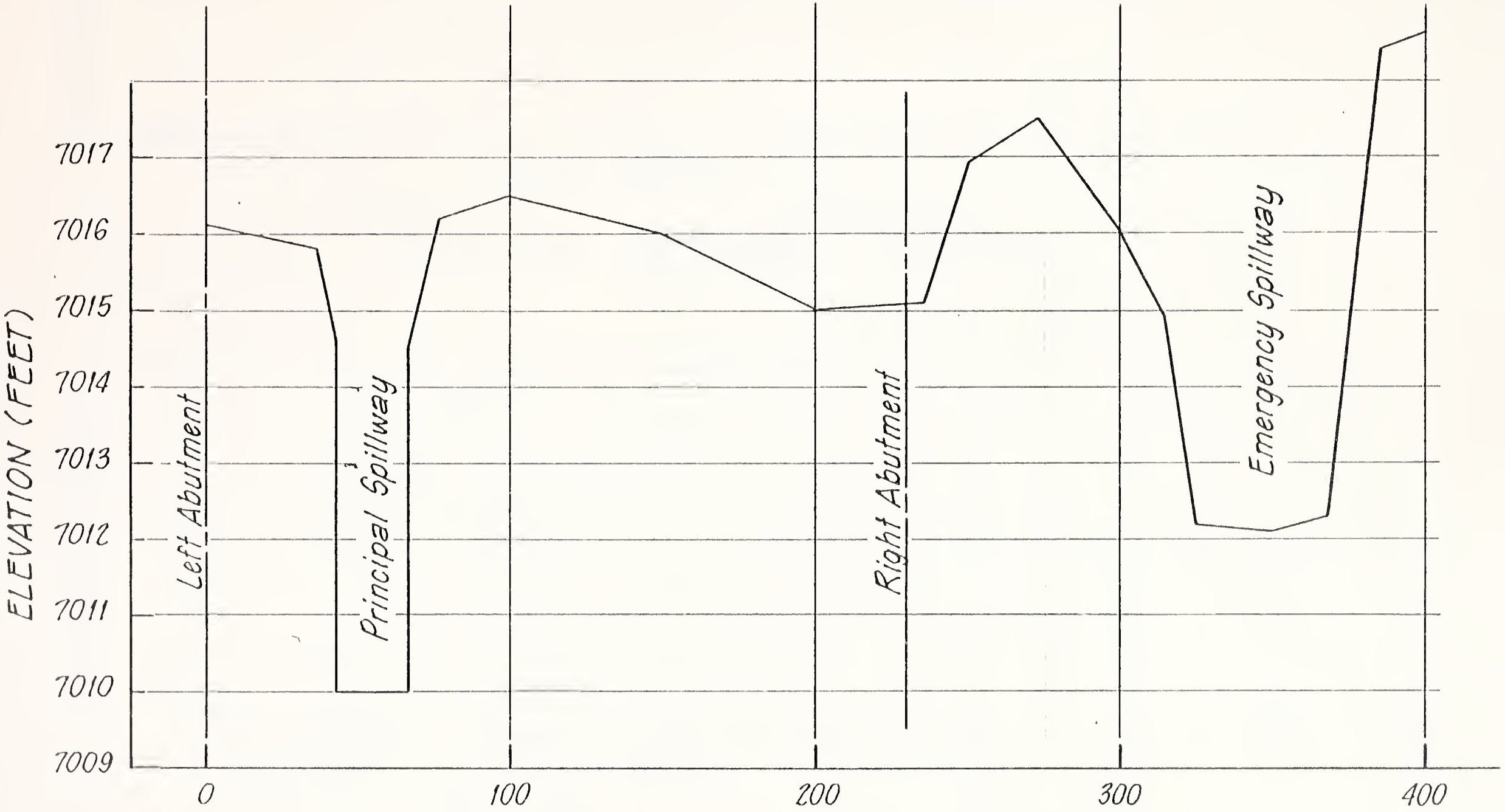



DAM CROSS-SECTION AT OUTLET

Scale: 1" = 20' Horiz.
1" = 10' Vert.

PLATE 2

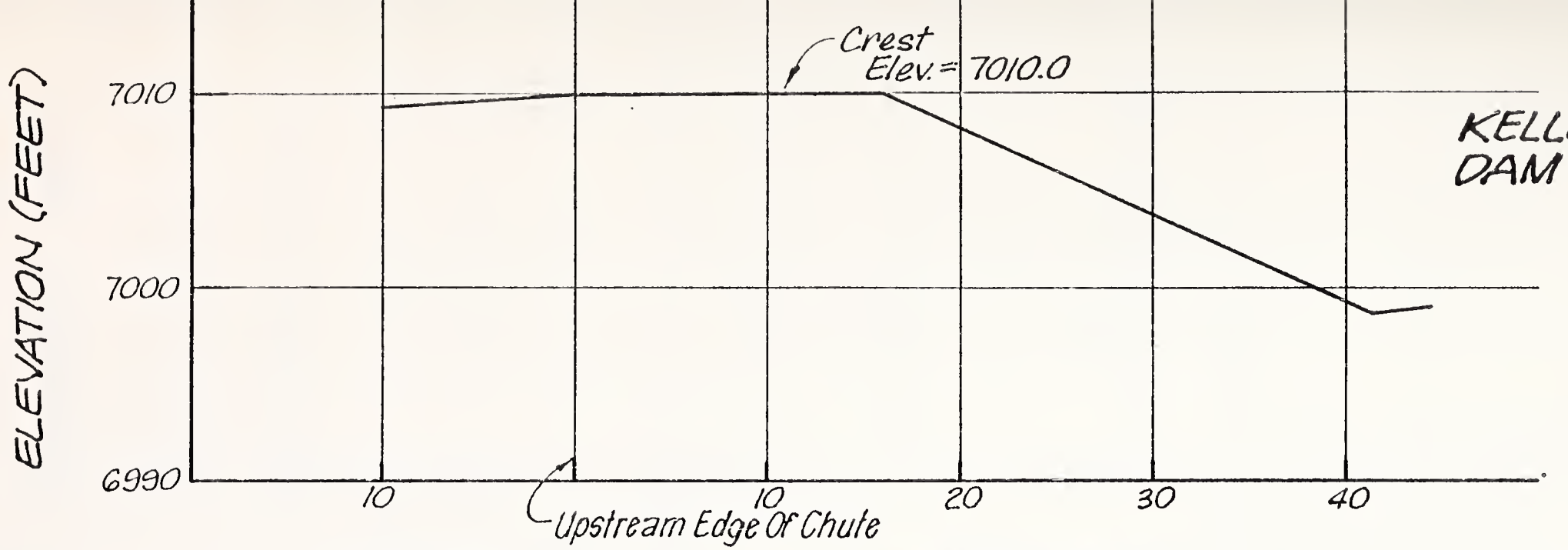
# KELLEY RESERVOIR DAM
## Montana




DAM CENTERLINE PROFILE

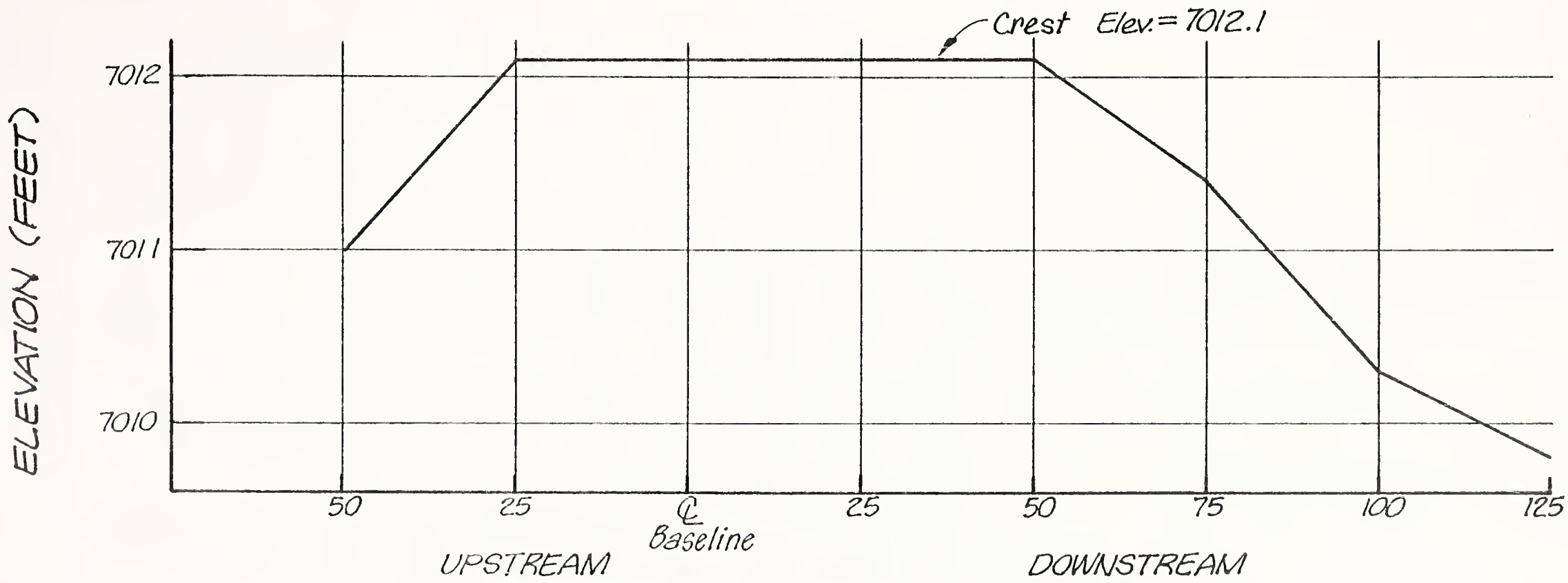
Scale: 1" = 50' Horiz.
1" = 2' Vert.

PLATE 3




**PRINCIPAL SPILLWAY PROFILE**

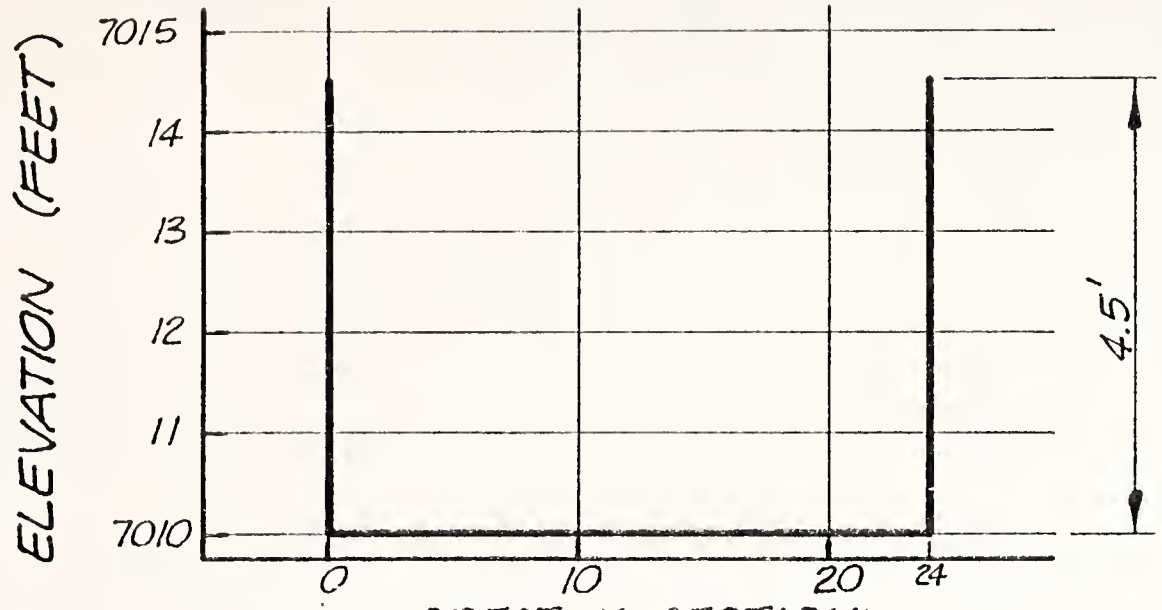
Scale : 1"=10'



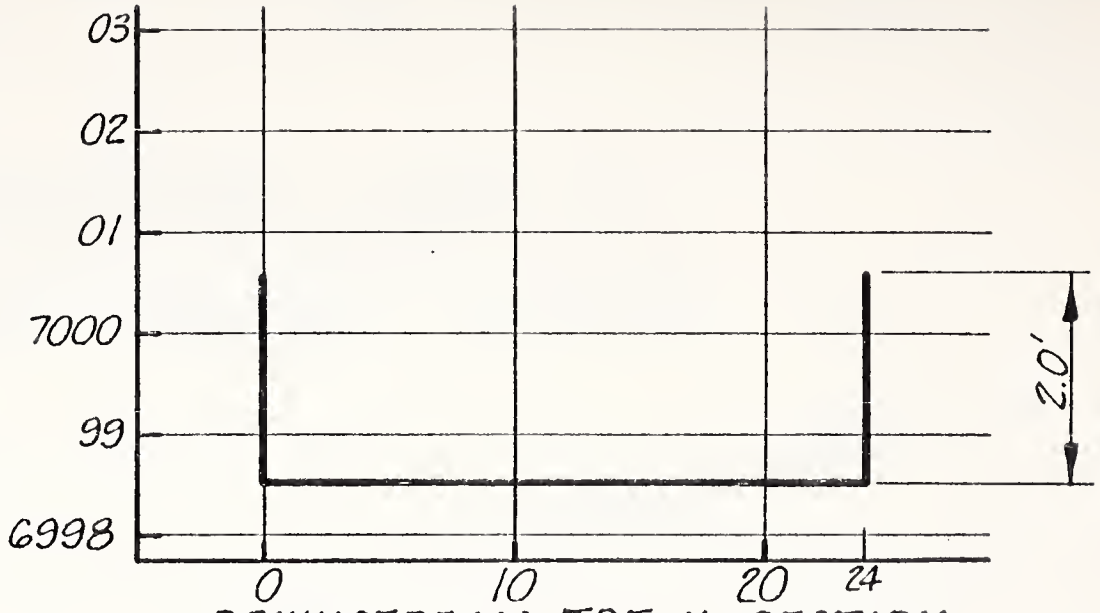

**EMERGENCY SPILLWAY PROFILE**

Scale : 1"= 25' (H)
1"= 1' (V)

PLATE 4



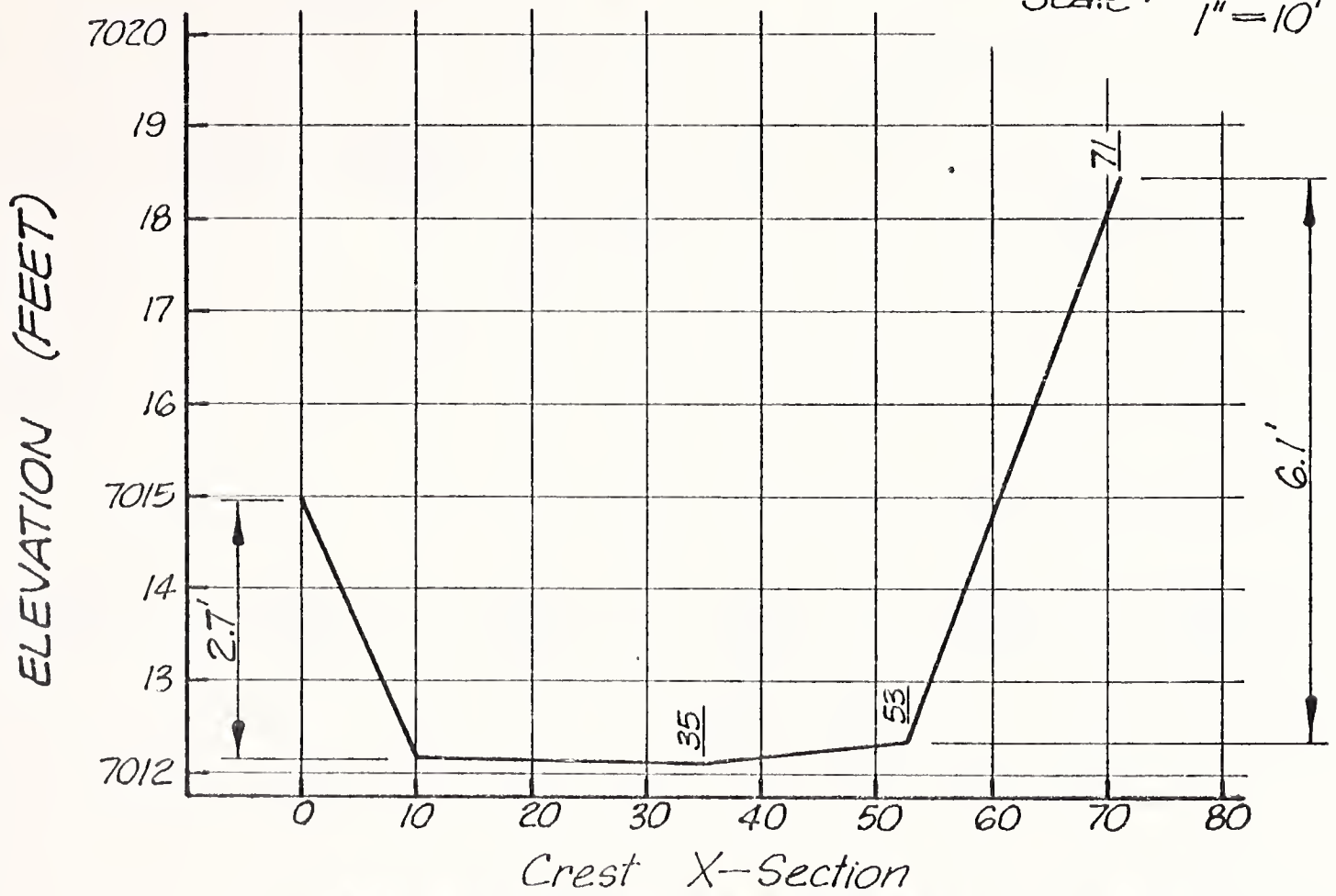

CREST X-SECTION




DOWNSTREAM TOE X-SECTION

## PRINCIPAL SPILLWAY X-SECTIONS

Scale: 1"=2.5' (V)
1"=10' (H)




Crest X-Section

## EMERGENCY SPILLWAY X-SECTION

Scale: 1"=2.5' (V)
1"=20' (H)

KELLEY RESERVOIR
DAM - Montana

PLATE 5

# ELEVATION - AREA & ELEVATION-STORAGE CURVES
## Kelley Reservoir - Montana

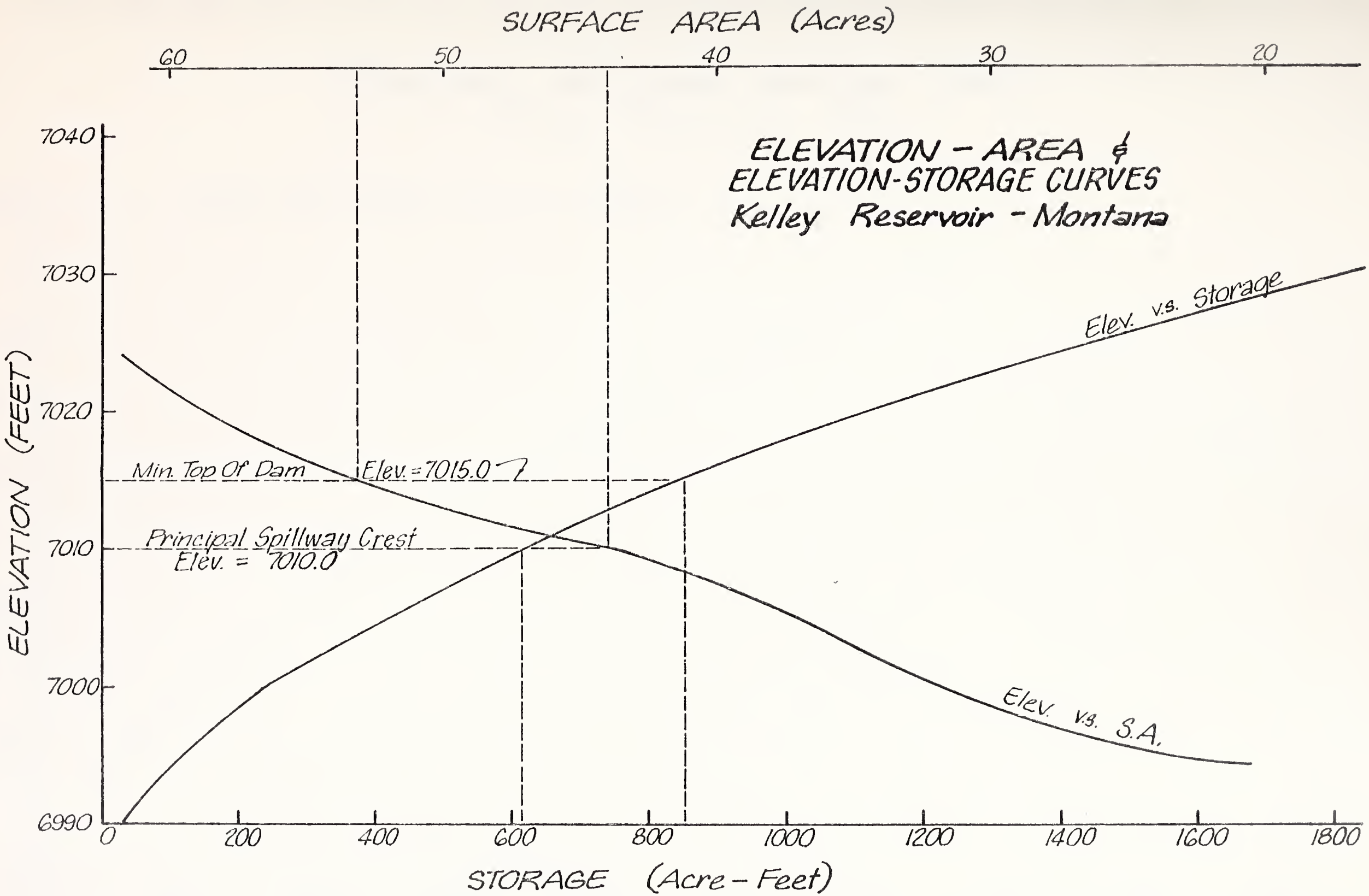



PLATE 6

# PRINCIPAL SPILLWAY RATING CURVE
## Kelley Reservoir Dam

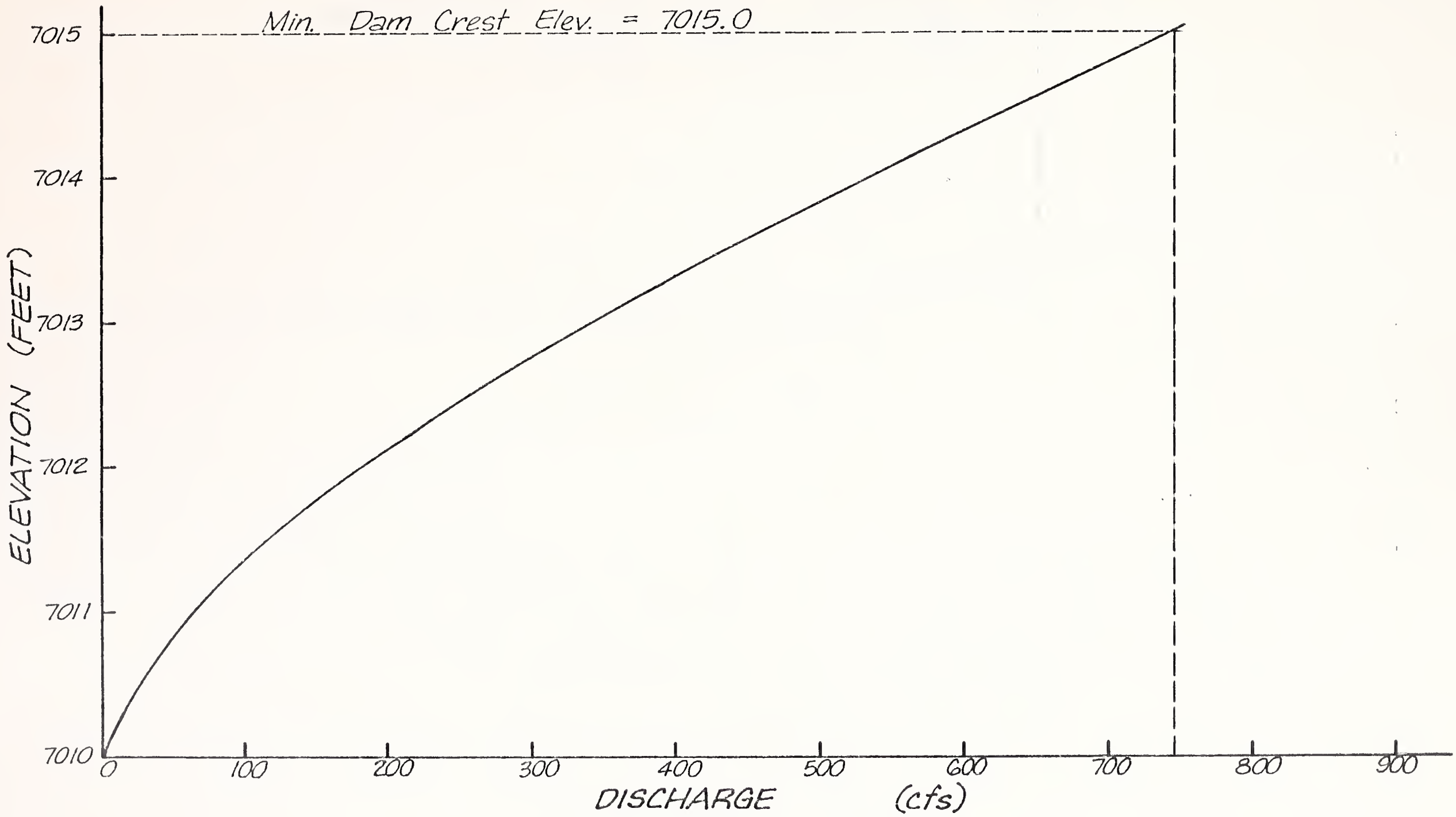



PLATE 7

# EMERGENCY SPILLWAY RATING CURVE
## Kelley Reservoir Dam

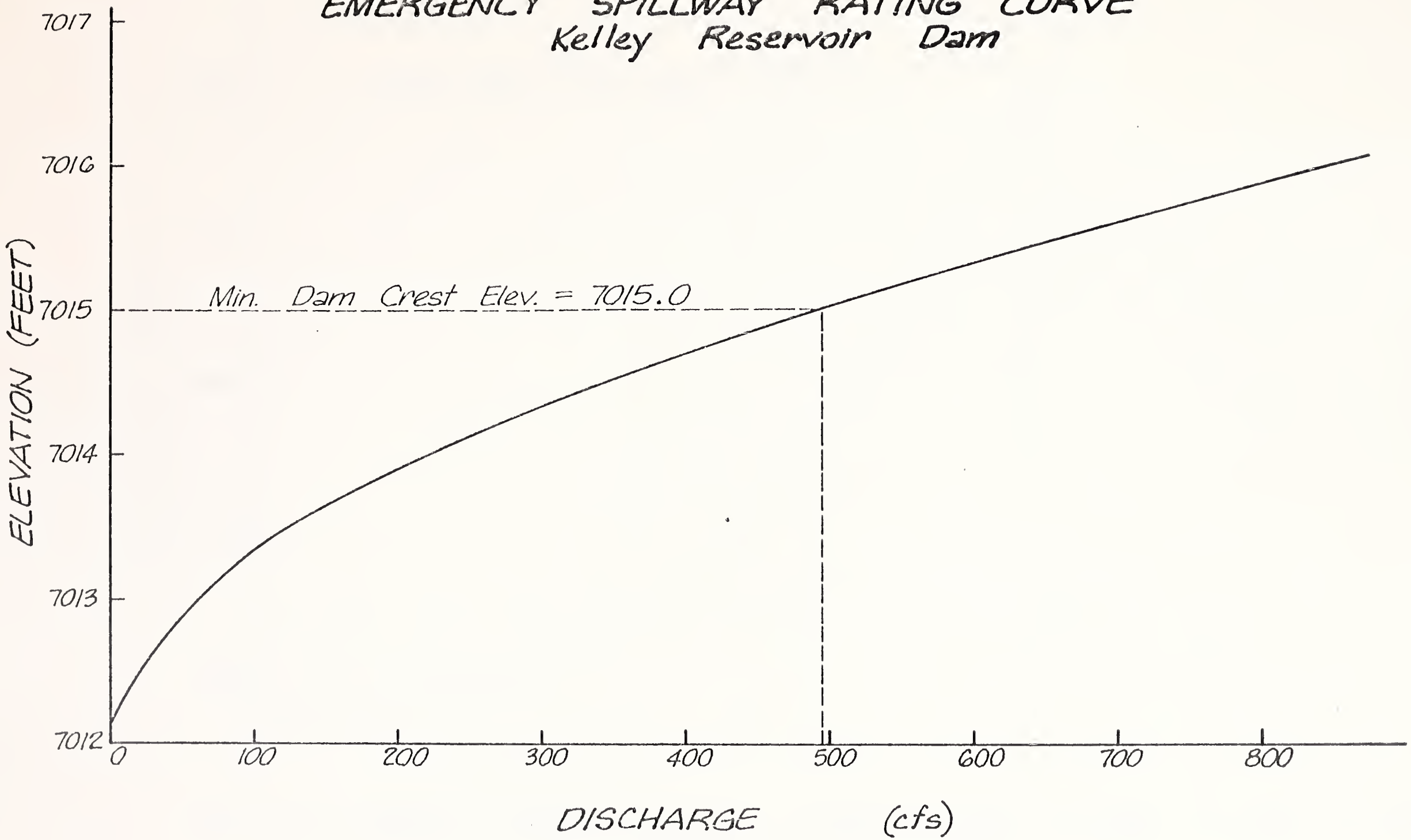



PLATE 8

# 34" WSP OUTLET DISCHARGE RATING CURVE
## Kelley Reservoir

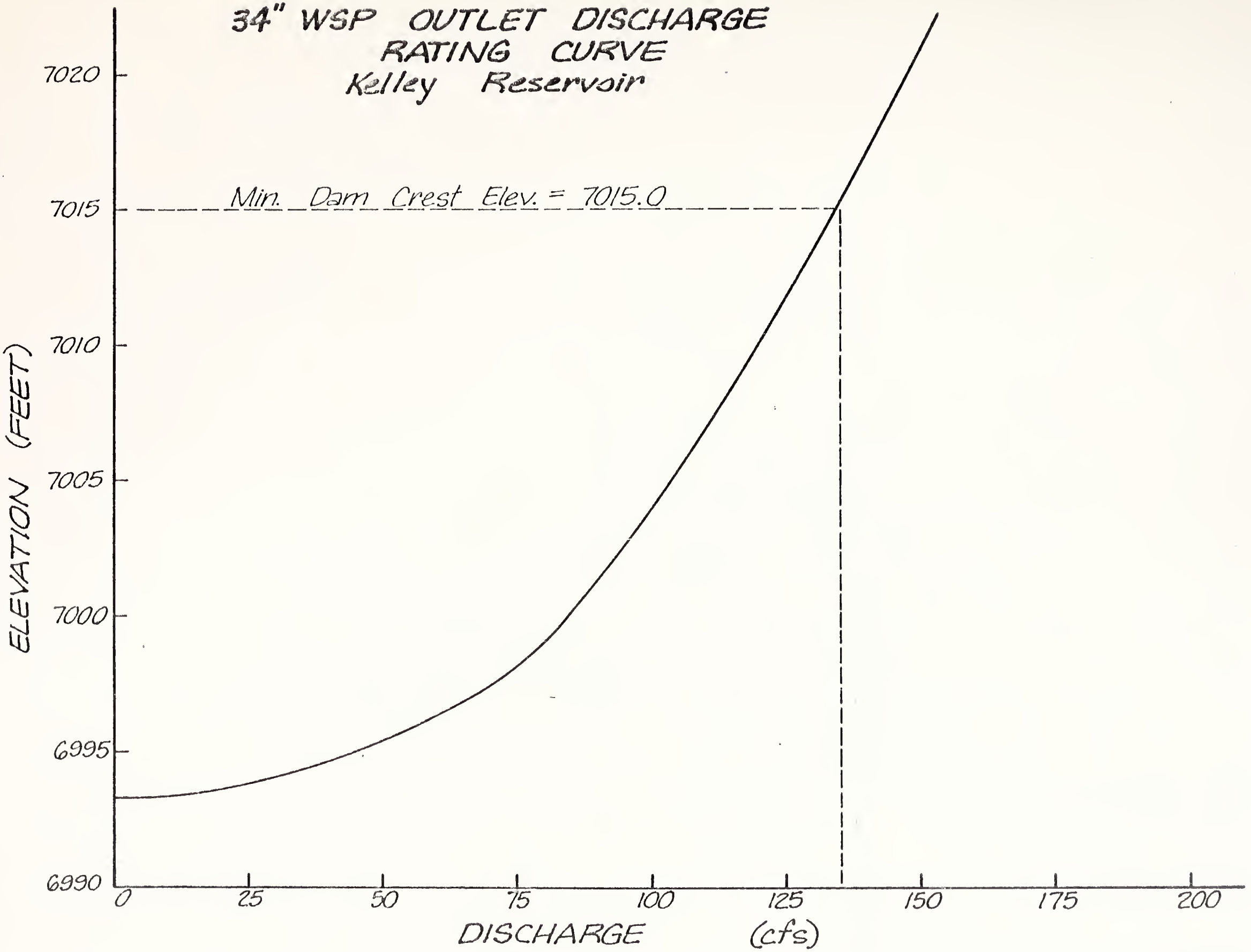
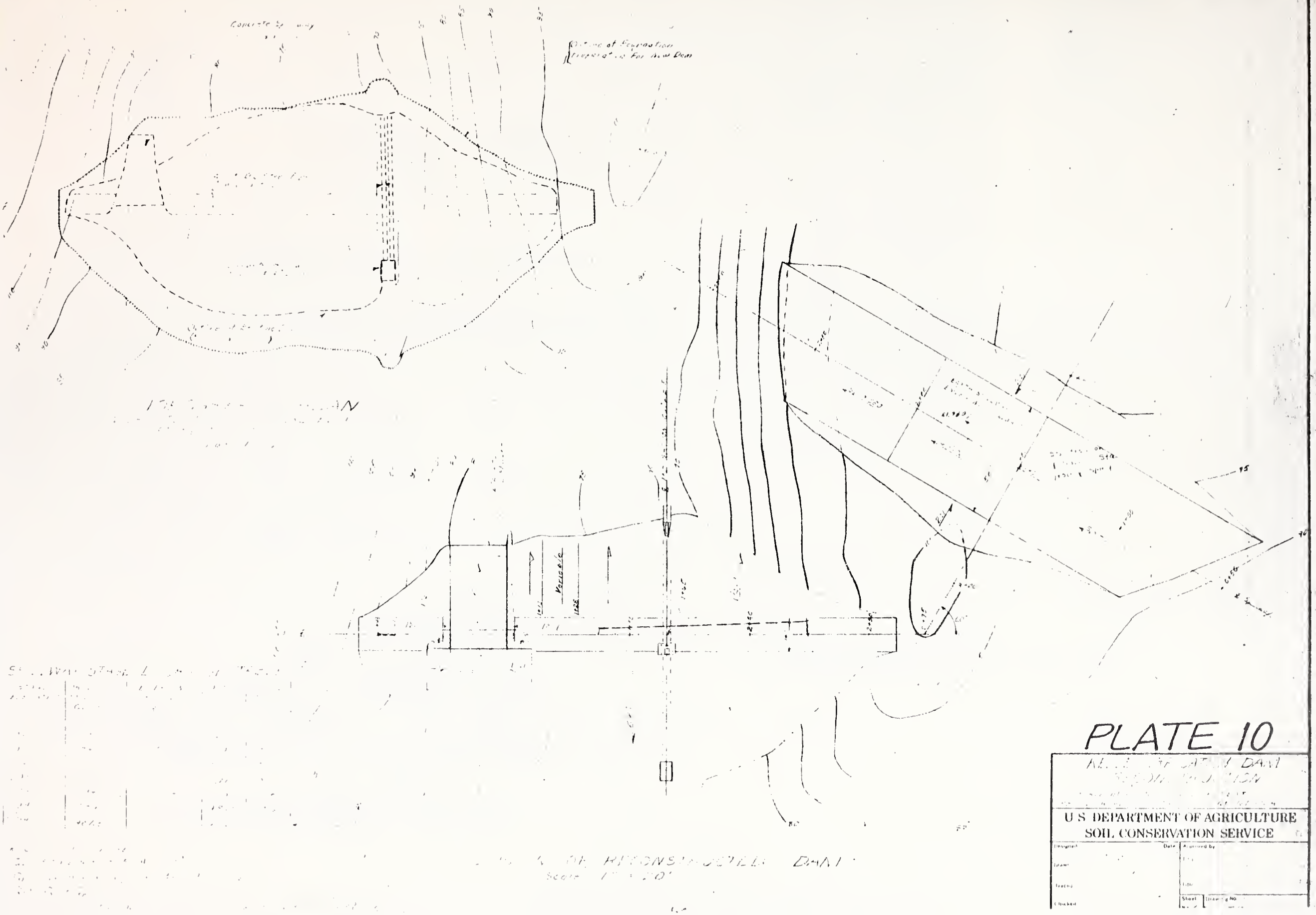


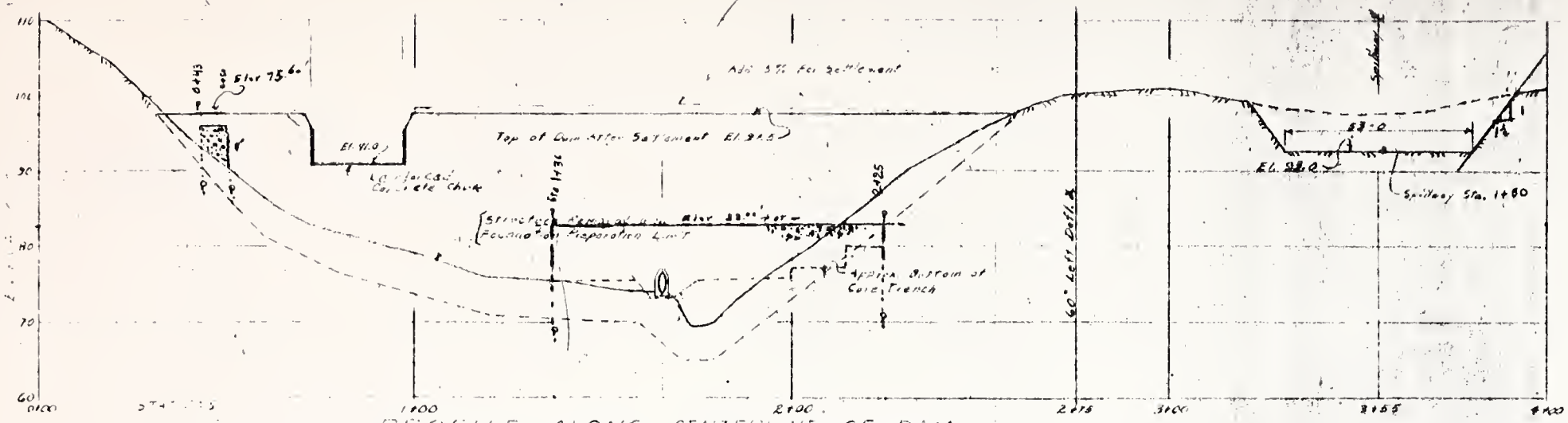

PLATE 9




# PLATE 10

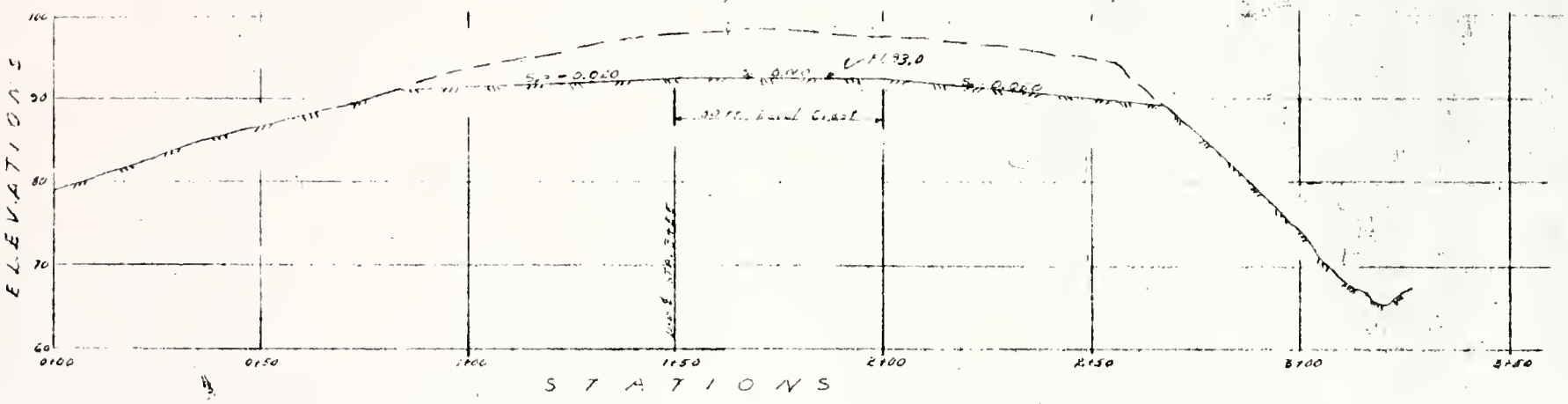
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed | Date | Approved by
Drawn | Title
Traced | Title
Checked | Sheet | Drawing No.



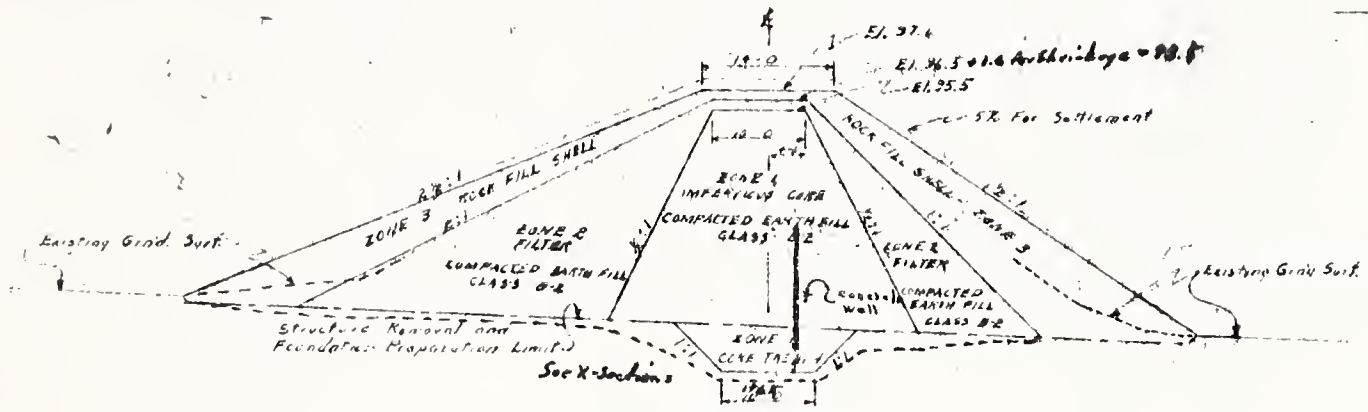

PROFILE ALONG CENTERLINE OF DAM

Scales: Vert. 1"=10' ; Horiz. 1"=20'



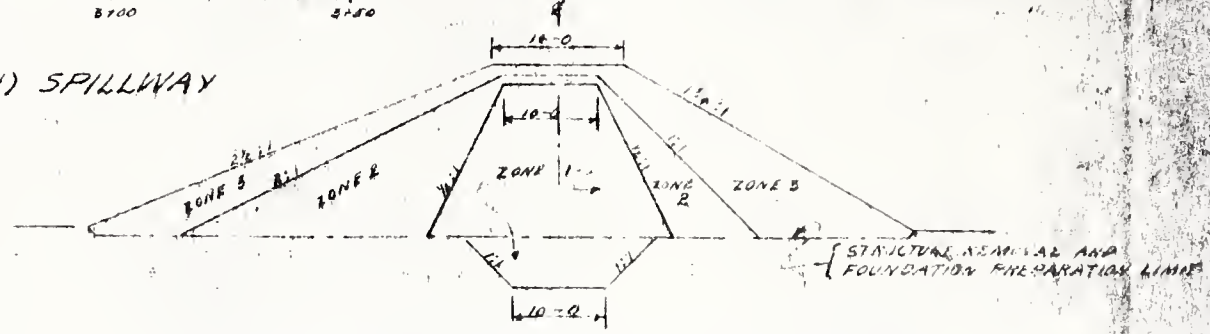

PROFILE ALONG CENTERLINE OF EMERGENCY (EARTH) SPILLWAY

Scales: Vert. 1"=10' ; Horiz. 1"=20'




TYPICAL EMBANKMENT CROSS-SECTION
FROM STATION 1+21 TO STATION 2+63

Scale: 1"=10'




TYPICAL EMBANKMENT CROSS-SECTION
FROM STATION 0+34 TO STATION 1+12

Scale: 1"=

NOTE The existing dam is to be completely removed and the earth materials stockpiled for use in the new embankment.

# PLATE 11

KELLEY IRRIGATION DAM
RECONSTRUCTION

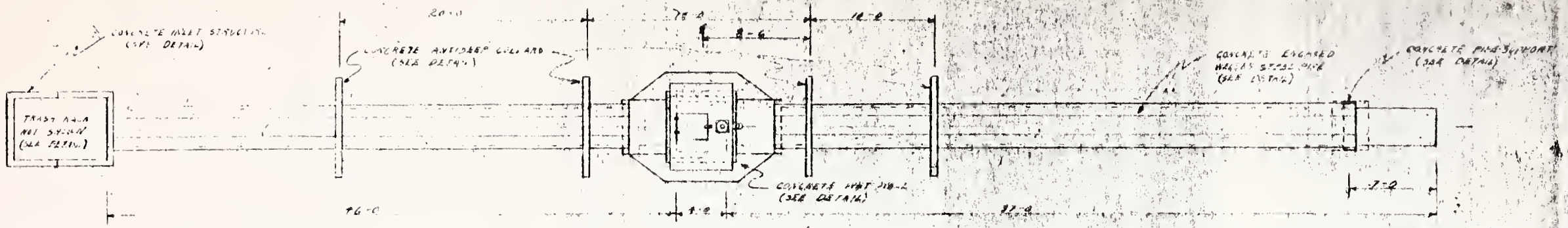
BEAVERHEAD NATIONAL FOREST
BEAVERHEAD COUNTY MONTANA

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

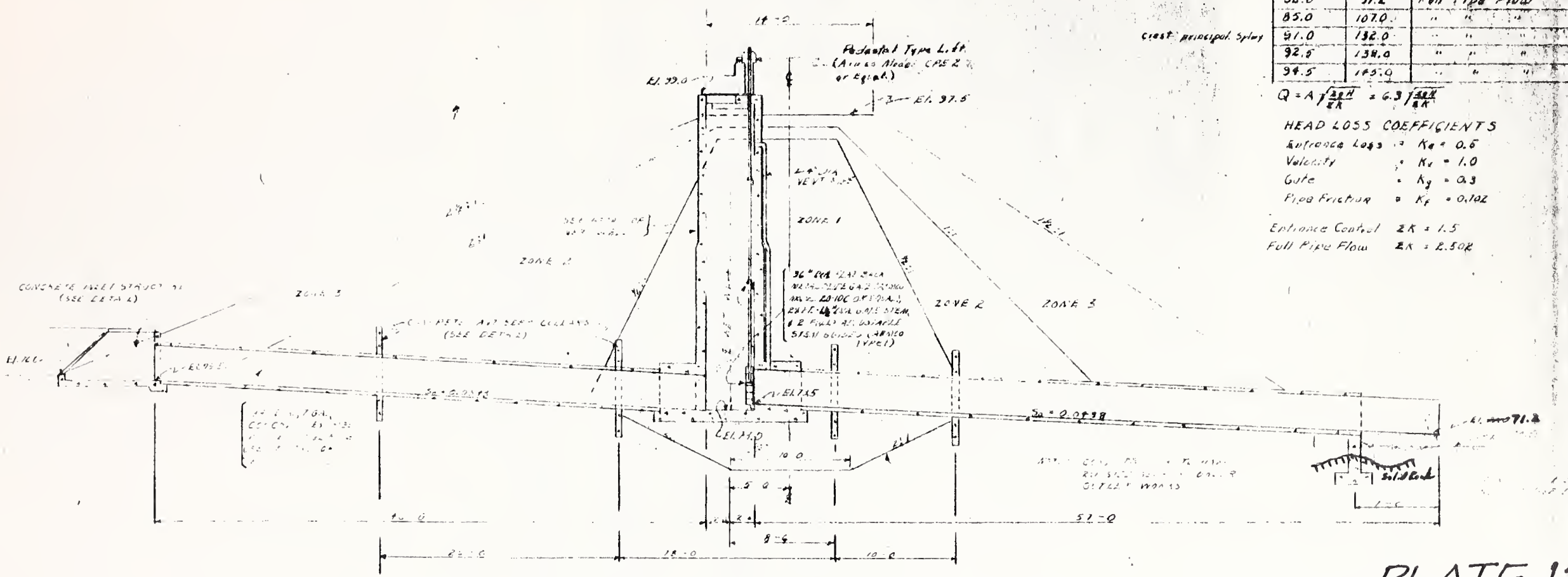
| | | | |
|---|---|---|---|
| Designed | | Date | Approved by |
| Drawn | K S | 2-65 | Title |
| Traced | K S | 2-66 | Title |
| Checked | | | Sheet No. 3 of 11 |
| | | | Drawing No. NT, E-67,021 |

Rev 5-66

Form SCS-378 (November 1964)




IRRIGATION OUTLET PLAN
Scale: 1" = 5'




CROSS-SECTION OF FLOWS CENTERLINE OF IRRIGATION OUTLET
Scale: 1" = 5'

## IRRIGATION OUTLET STAGE DISCHARGE TABLE

| STAGE ELEVATION | Q cfs | FLOW CONTROL |
|---|---|---|
| 79.0 | 59.5 | Entrance Control |
| 80.0 | 72.5 | " " |
| 81.0 | 83.5 | " " |
| 82.0 | 91.8 | Full Pipe Flow |
| 85.0 | 107.0 | " " " |
| 91.0 | 132.0 | " " " |
| 92.5 | 138.0 | " " " |
| 94.5 | 145.0 | " " " |

crest principal spillway

$Q = A\sqrt{\frac{2gH}{\Sigma K}} = 6.3\sqrt{\frac{H}{\Sigma K}}$

HEAD LOSS COEFFICIENTS

Entrance Loss = $K_e = 0.5$
Velocity = $K_v = 1.0$
Gate = $K_g = 0.3$
Pipe Friction = $K_f = 0.102$

Entrance Control $\Sigma K = 1.5$
Full Pipe Flow $\Sigma K = 2.50R$

# PLATE 12

KEY EY IRRIGATION DAM RECONSTRUCTION

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

| | | | |
|---|---|---|---|
| Designed | Date | Approved by | |
| Drawn | | Title | |
| Traced | | Title | |
| Checked | | Sheet No. 4 of | Drawing No. MT.5 - 3.C.E1 |

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

TED SCHWINDEN, GOVERNOR

32 SOUTH EWING

STATE OF MONTANA

(406) 449-2872 ADMINISTRATOR
(406) 449-3962 WATER RIGHTS BUREAU
(406) 449-2872 WATER SCIENCES BUREAU
(406) 449-2864 ENGINEERING BUREAU
(406) 449-2872 WATER PLANNING BUREAU

HELENA, MONTANA 59620

March 6, 1981

Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Attn: Ralph Morrison

Dear Ralph:

Re: Hoskins-Westeregger, Inc. Dam Safety Inspection Report
on Kelley Reservoir Dam (MT 1563)

We have reviewed the above referenced final draft report. We concur with the findings and recommendations and find that it satisfies the criteria of the Phase I report.

Minor editorial comments have been discussed with your staff, and we understand these will be incorporated in the final report.

Thank you for this opportunity to review and comment on the final draft report on Kelley Reservoir Dam.

Sincerely,

Richard L Bondy

Richard L. Bondy, P.E.
Chief, Engineering Bureau

RB:AT:lj

AN EQUAL OPPORTUNITY EMPLOYER

United States
Department of
Agriculture

Soil
Conservation
Service

P.O. Box 970
Bozeman, MT
59715

March 10, 1981

Sidney Knutson, P.E.
Assistant Chief
Engineering Division
Seattle District Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Dear Mr. Knutson:

Thank you for the opportunity to review the final draft report on the Kelley Reservoir Dam (MT-1563).

Our comments relating to specific report statements are:

> Page i, last sentence: We feel the downstream hazard is over-rated as the first and second inhabitable structures are 5 and 8 miles downstream respectively. During storms of less magnitude than described, the structures would be flooded by runoff from below the dams before a breach wave arrives.

General Comments:

We do not feel the meteorologic and hydrologic conditions used to develop the PMF are realistic. The conditions and criteria selected attempt to eliminate the element of risk to a degree that is not reasonable or practical.

We request that the meteorologic and hydrologic assumptions and conditions be fully presented and justified in the report.

Sincerely,

Van K Haderlie
FOV State Conservationist

cc:
Ray Smith, State Conservation Engineer, SCS, Bozeman
Dave Jones, Environmental Engineer, SCS, Bozeman, MT

The Soil Conservation Service
is an agency of the
Deoartment of Agriculture

SCS-AS-1
10-79.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FEDERAL BUILDING MISSOULA, MONTANA 59801

RECEIVED
APR 13 1981

7500

MAR 26 1981

Mr. Sidney Knutson, P.E.
Assistant Chief, Engineering Division
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, Washington

Dear Mr. Knutson:

We have reviewed the preliminary draft report for the Phase I inspection of Kelly Reservoir Dam and have the following comments:

We agree a more detailed hydrologic analysis is needed to determine the hazard this dam presents.

Sincerely,

L. D. BRUESCH
Acting Director
Engineering

*Schellack Engineering & Assoc.*
*Gleed Building, 30 S. Montana St.*
*P.O. Box 1333*
*Dillon, Montana 59725*

—ENGINEERING SURVEYING
—FOREST SURVEYS
—MUNICIPAL ENGINEERING

LOWELL J. SCHELLACK, PE
Business - 406-683-2227
Residence - 406-683-4067

March 9, 1981

Mr. Sidney Knutson, P.E.
Department of the Army
Seattle District
Corps of Engineers
P. O. Box C-3755
Seattle, WA 98124

Dear Mr. Knutson:

I have been requested by the "Kelley Reservoir and Irrigation Company" to make a response to your draft report on the Kelley Reservoir Dam Project, inspected September 19, 1979, and forwarded February 4, 1981, by your agency.

As you have stated in the report, the dam was designed by the Soil Conservation Service, a federal agency, and constructed to that design in 1965. Another federal agency, the Farmers Home Administration, financed the project based on the SCS design standards which were in effect at that time. The Irrigation Company built the dam according to those standards and to the satisfaction of the two federal agencies.

I do not agree with some of the concepts you have used in preparing your figures. Assuming a 100% run-off from the drainage area seems to be ultra conservative. Also, on page 16, you project 3220 acre feet of discharge from Estler Lake above Kelley Lake. Estler Lake's total storage is only 620 acre feet. I don't understand the relevancy of this figure as the total run-off from the Estler Lake drainage is 2790 acre feet for a 24 hour PMP. It seems that this figure has already been projected into the 19,480 acre feet discharge listed on page 17 of the report.

As for your recommendations, I will respond to them in order as listed in paragraph 3.2 of your report:

1. Immediately develop, implement and periodically test an emergency warning plan for use in the event of dam overtopping.

ACTION: The Company will equip the ditch rider with a two-way radio that is on the Beaverhead County Sheriff's Department's frequency to provide early warning. The ditch rider works this drainage on a daily basis.

2. After removing all rust, use a proven rust resistant paint system to paint all rusted metal on the trash rack and the exposed portion of the welded steel conduit.

ACTION: I agree that this should be done and the Company indicates they will perform this work.

3. Remove debris from the vicinities of the embankment and the spillway.

ACTION: I agree that this should be done and the Company indicates they will perform this work.

4. Inspect the outlet conduit and repair as required.

ACTION: I agree and the Company indicates they will initiate this action.

5. Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity, and modify the project as studies indicate. Include effect of upstream Estler Dam Project.

ACTION: I don't agree that this should be a responsibility of the Company since they installed the dam in 1965 upon advice of the SCS, experts in the field of dams and dam safety. However, should the DNRC want to conduct more detailed studies, the Company indicates they would lend their assistance to such a program.

6. Re-evaluate embankment stability and verify design assumptions with regard to position of embankment phreatic surface, and filter characteristics. Include an evaluation of seismic stability during a design earthquake. Stability evaluation should be by a qualified Geotechnical Engineer.

ACTION: I don't agree that this should be a responsibility of the Company since they installed the dam in 1965 upon advice of the SCS, experts in the field of dams and dam safety. However, should the DNRC want to conduct more detailed studies, the Company indicates they would lend their assistance to such a program.

7. Develop and implement a periodic maintenance plan for the dams and appurtenant structures.

ACTION: The Company already has an active program, as evidenced by the good maintenance condition of the dam.

8. Establish a program for periodic, comprehensive safety inspections at no more than 5-year intervals. These inspections should be conducted by engineers qualified in the design, construction, operation and maintenance of earth dams.

ACTION: Such a program already exists.

I hope you find these comments useful in preparing your final report.

Very truly yours,

Lowell J. Schellack

Lowell J. Schellack, P.E.
Civil Engineer

bb

I, TOM LARSON, President of the "Kelley Reservoir and Irrigation Company", concur with the above findings in regard to your report and cover letter dated February 4, 1981. Thank you for the opportunity to respond to your draft report.

Tom Larson Pres.

Tom Larson, President
Kelley Reservoir and Irrigation Co.